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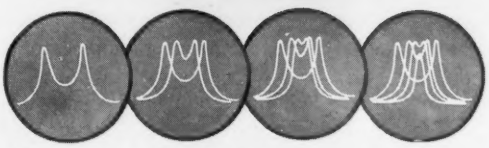

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Euratom

Recently the representatives of six European nations signed both the common-market pact for the establishment of the European Economic Community and the Euratom agreement, formally known as the European Atomic Energy Community, which provides for a European Atomic Energy Commission to distribute nuclear material to the member states and to grant financial and technical assistance to research and development projects within the European Economic Community. The treaties for Euratom and EEC were signed by Italy, France, West Germany, Belgium, the Netherlands, and Luxembourg, and we hope that these pioneering governments will proceed with speedy ratification. These countries have a combined population of 160 million; they represent, therefore, more than one-half of non-Soviet Europe.

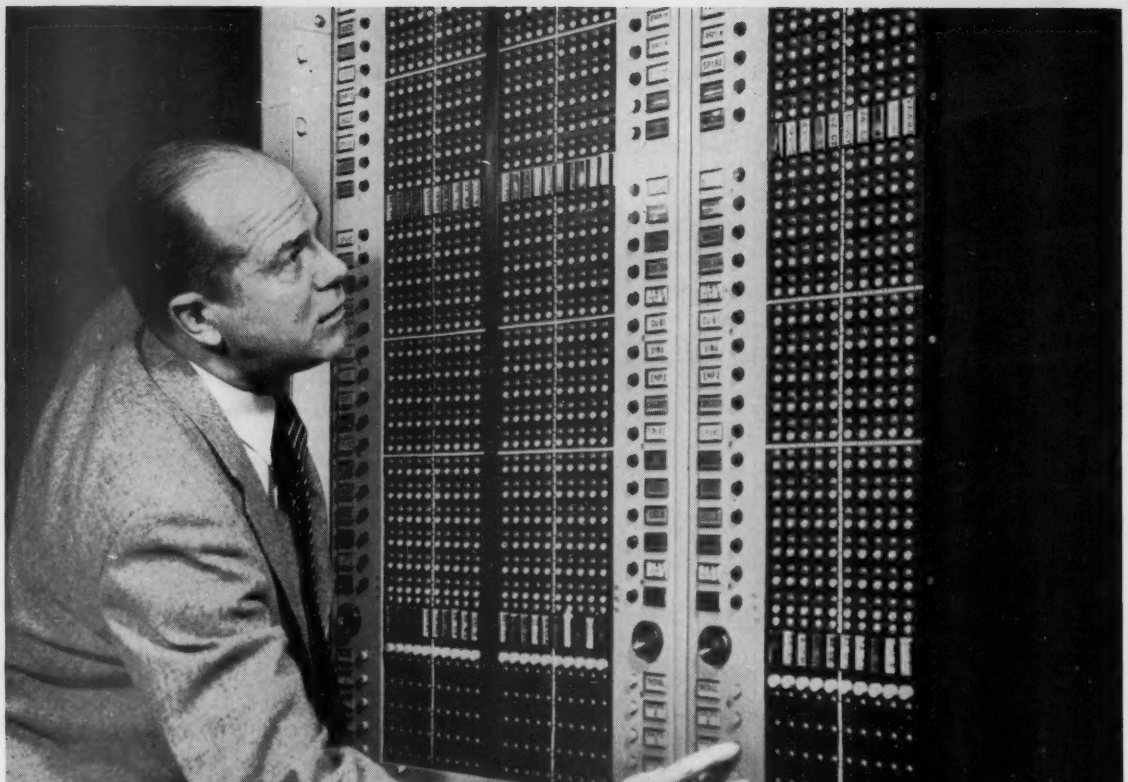
The Euratom agreement stipulates that the European Atomic Energy Commission shall be the owner of all nuclear material produced by member states, and that all contracts made with third parties outside the common-market area must be approved by the commission. This agency will handle procurement of nuclear raw materials for member nations and will also have first buying right on all the nuclear production of the Euratom countries. Further, the commission will coordinate the research programs of the member states and create a combined training and research center to carry out projects that the states are unable to undertake individually.

A complex system for exchange of nonpatented and patented information and collection of research data has also been incorporated in the agreement. Another major task of the commission will be the establishment of common health and protective measures to be applied in the use and production of nuclear materials.

The United States has reacted favorably to Euratom. After a series of talks between U.S. officials and three Euratom representatives in February, the State Department and the Atomic Energy Commission issued a statement promising assistance and fully endorsing the Euratom plans (15 million kilowatts of atomic power plant capacity within 10 years). This country has agreed to supply nuclear fuel, and already a five-man team of American specialists is preparing to leave for Europe. Britain, too, is sending a groups of consultants and has offered to train European scientists in the reactor schools at Harwell and Calder Hall and to "facilitate contracts between United Kingdom firms and firms within the Euratom countries interested in building nuclear reactors."

The long-sought United States of Europe need no longer be considered an idealist's dream, for it is growing from the establishment among nations of effective, mutually beneficial working arrangements on specific problems. For example, in 1953 the European Coal and Steel Community was formed; its members are identical with those of Euratom and EEC.

Euratom and EEC had their inception at a meeting at Messina, Italy, in June 1955, when the foreign ministers of the six cooperating countries adopted a resolution saying that their governments believed that it was the "right moment to start anew on the way towards a united Europe. . . ." Action to put the resolution into effect was begun at once, and in the remarkably short period of 19 months the complex technical problems and conflicting national interests involved in such a revolutionary undertaking are well on the way to being resolved. Although the EEC and Euratom treaties are so far only pledges, since they still have to be approved by the governments concerned, they may well turn out to be milestones in the integration of Europe.—B. P.



Bell Laboratories engineer Cyril A. Collins, B.S. in E.E., University of Washington, demonstrates new TV switching control panel for black and white or color. Complex switching connections are set up in advance; in a split-second a master button speeds dozens of programs to their destinations all over the nation. Special constant-impedance technique permits interconnection of any number of broadband circuits without picture impairment.

Telephone science speeds TV enjoyment

Telephone science plays a crucial part in your TV entertainment. An interesting example—one of many—is the latest TV switching center developed at Bell Telephone Laboratories.

Switching centers control the transmission of programs which come to your local TV station over Bell System facilities. To be available exactly on cue, programs must be switched at high speed and with very great accuracy.

To create the new switching center Bell Laboratories engineers borrowed from the switching control art which handles your dial telephone calls. They developed a special control panel which puts complex switching patterns within the easy grasp of one man. By pushing buttons, he sets up—and double-checks—forthcoming network changes far ahead of time. On cue he presses a master button which sends the programs racing to their respective destinations around the nation.

To connect the broadband circuits, the Laboratories engineers developed a new video switch which operates on a constant-impedance principle. The new switch permits the interconnection of any number of circuits, without the slightest impairment of transmission quality.

Thus the technology which serves your telephone also works for your TV enjoyment.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

3 May 1957, Volume 125, Number 3253 SCIENCE

Instrumentation for Bioengineering

Wallace E. Frank

Bioengineering is the field of applied science which is concerned with the application of the physical science techniques to problems in medicine and biology. Bioengineering also applies to the general area of the extension of normal and abnormal limits of human physical capabilities. While bioengineering encompasses much that requires instrumentation, one of the major divisions of the field is instrumentation development per se.

Perhaps we can best explore this general field by considering specific examples of instrumentation for bioengineering. As a matter of fact, most of those which I have chosen are ones on which my own group has actively worked.

Intraocular Pressure Measurement

Consider the problem of measuring the pressure inside the eye, which is of great importance in the detection of glaucoma. It is not practical to put a pressure probe inside the eye. Usually this intraocular pressure is measured by means of a tonometer, a special form of indentation-hardness tester that is placed over the eye, loaded with a given force, and indicates the depth of penetration. The reference plate rests on the rigid front of the eye and the moving plate, on the cornea. Although it is a very useful instrument, the tonometer nonetheless has many drawbacks, and there is need for a better method of measuring intraocular pressure. We are working to develop such a method. A technique devised by Karl Sittel of our laboratories involves measurement of vibration of the eye. Nothing will touch the eye but a fluid column. Preliminary experiments indicate the feasibility of this method, and we are just starting a more ambitious program to develop and evaluate the technique fully.

Endoscopy

Another instance of a physical limit that must be overcome by an instrument is exemplified by the problem of the endoscope. Endoscopes can be thought of as periscopes which are used to examine interior body cavities. Typical of these are the gastroscope for examining the stomach, the bronchoscope, and the cystoscope. These devices do not always permit the physician to view the entire area of interest. For instance, an important area of the stomach is frequently beyond the field of view of a gastroscope. Present endoscopes are not always as easy to place as both physician and patient would like them to be; they are neither flexible nor controllable enough.

An entirely new principle of image transmission is now being applied to endoscopy, and the press has recently carried a number of news stories telling of some work, at the Institute of Optics in Rochester, directed toward the use of the fibroscope, a flexible cable which consists of a bundle of fine, light-transmitting filaments. Fibroscopes are much more flexible than present gastroscopes and provide images of good quality. We, too, have been working on this problem. But we have extended our work beyond the optical features of the design and have developed a technique for controlling the configuration of the fibroscope so that the physician may easily view what would otherwise be very inaccessible places.

Also, in the field of endoscopy there is a need for better light sources which will permit photographing these body cavities in true color and at high speeds so that the motion may be "stopped." Such photographs would be useful in record-keeping, diagnosis, and teaching. Present light sources are not brilliant or long-lived enough for the job.

Reading Device for the Partially Sighted

Much work has been done in prosthetic and sensory aids to help handicapped individuals to perform normal actions in a more nearly normal manner. For instance, for the partially sighted we have developed the projection magnifier (Fig. 1). This is an opaque projector which produces a magnified, high-contrast image that can be read by a great number of the partially sighted who cannot comfortably read with other instruments. This device is an image magnifier, but many design problems of screen size, magnification, contrast, illumination, control of field of view for scanning, and material insertion had to be solved, in terms of the needs of the partially sighted, before the development was completed. A large-scale research and test program was undertaken for the purpose.

The first projection magnifier that we made was a walk-in model which required 18 automobile head lamps of 32 candlepower each and, naturally, a large blower to keep the reader from being baked alive. In tests of this model, with a number of subjects, relationships between visual acuity, reading speed, and magnification were determined. We came to the conclusion that for people who needed 10 times or more magnification, reading required considerable effort, and not many of them were sufficiently interested to take the trouble.

We also learned—and this seems obvious in retrospect—that persons with poor visual acuity tend to press their eyes close to the screen and move their heads as they read across the line. Even when manual control of scan was provided, many preferred to leave the material alone, scanning as much as possi-

The author is chief of the bioengineering section, Chemistry and Physics Division, of the Franklin Institute Laboratories for Research and Development, Philadelphia, Pa. This article is based on a paper presented 26 Dec. 1956 at the annual AAAS meetings in New York.

Fig. 1. Use of the projection magnifier, reading device for the partially sighted.

ble by head rather than by hand motion. This was even more likely to be true as visual acuity decreased. Finally, we concealed all but a small portion of the screen and determined the reading speed and comprehension of children with the small screen as compared with the large. The differences were small, and the economic advantages of the small machine and the small screen far outweighed the minor improvement in performance with the large machine.

The small-screen projection magnifier was then developed and subjected to preliminary test with partially sighted individuals of all ages. Thereafter, 50 test units were constructed and carefully evaluated in a 2-year test program. The results of the evaluation revealed a need for this type of device and pointed out the advantages and deficiencies of the test models. Since that time, a commercial producer has been licensed to manufacture and distribute projection magnifiers of an improved design, thus bringing the partially sighted a new reading aid. The same optical principles are being applied to an industrial inspection device. Thus, this work not only has benefited the class which we originally set out to help but is serving industry as well.

Guidance Devices for the Blind

Several programs of development of devices for the blind are also currently under way. One phase of the problem, navigation, is being worked on in several places. Guidance devices based on more sophisticated principles than the principle of an ordinary cane have been undergoing development since World War II.

These devices are intended to permit a blind traveler to get about more safely, more rapidly, and with less stress than is possible with a guide dog or an ordinary cane (Fig. 2). They employ ranging and proximity principles. They use ambient and self-generated radiations. They use sound, light, radio, and radar. While none have yet gone very far beyond the development laboratory, these instruments are good examples of bioengineering developments which involve adapting known engineering techniques to a new setting. At all of the meetings of those working in this field the most significant discussions are likely to be about the requirements for such guidance devices, the characteristics of the people who are to use them, the situations in which each device is or is not suitable, and the many intangibles, rather than about engineering features. The basic philosophic design problems are much more difficult to answer than the engineering problems, and frequently it is very difficult to formulate the design problems in any satisfactory way.

Reading Devices for the Blind

Other groups are striving to develop reading machines that will enable the sightless to comprehend ordinary printed material. These projects are not yet complete, but they are building an understanding of the requirements, and this is necessary before we can proceed with the proper development.

The crux of most bioengineering instrumentation problems is in setting the specifications; the development of reading machines for the blind illustrates this point.

The means for converting ordinary printed material into a code is well within the competence of those working in the field of commercial reading machines. Converting a letter-by-letter translation of the text into any other reasonable code is possible with modern computers. For instance, the converter could use the contractions used in advanced Braille. All this would be expensive, and whether it is worth while depends on how many of the blind read Braille or, more important, on how many would read Braille if there were a greater range of material available.

Or is the problem of reading one's own mail even more important? How many of the blind would go to how much trouble to learn to use a device that would let them read their own mail, labels, and so on? Just to read a cookbook might mean a great deal to someone.

Prosthetic and Protective Equipment

In recent years a great deal of scientific work has been done on the development of prosthetic devices. The Veterans Administration-sponsored artificial-limb program has brought an engineering approach to an important problem of device development and fit, and with notable success. Our own part in this work has been largely to develop pressure-sensing devices which can determine the pressure pattern between the stump and the stump socket, both at rest and during motion. Studies of the pressure pattern are expected to lead to a more rational basis for fitting, as well as designing, the attachment between prosthesis and man.

The basis of this work in prosthesis began some years ago when we were asked by the Government to develop instrumentation which could be used in measuring the pressure between man and his environment. The immediate application was to the design of sleeping bags. The problem was to develop a pressure-sensing element which would be so thin and flexible that it would cause no discomfort or alteration of the pressure pattern and yet would have adequate sensitivity and be able to operate either through telemetering or with long cables, so that the motion of the individual being tested would be unhampered. A survey revealed that no existing instrument small enough, thin enough, and flexible enough to suit these requirements was available.

A number of people had made thin pressure-sensing devices, but these all suffered from operational defects which made them unsuitable for our purpose. For instance, R. Plato Schwartz and Arthur L. Heath, at the University of

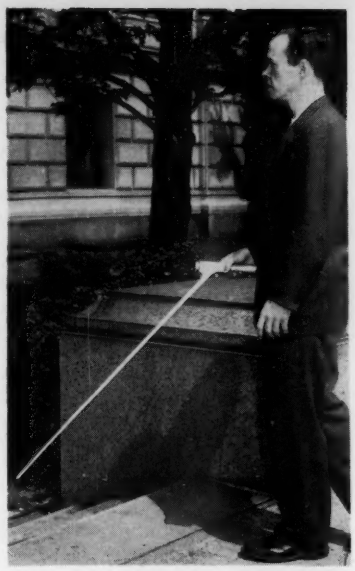


Fig. 2. Use of the sensitive cane, guidance device for the totally blind.

Rochester School of Medicine, had developed resistance-type pressure patches, which they used with some success in gait studies, and had also worked on strain-gage transducers. Strain-gagé transducers, unfortunately, seem to require some sort of reference structure and a diaphragm which is stressed under load. The problem of making a thin, flexible, strain-gage transducer that would not be felt against the body and would not, of itself, alter the pressure distribution pattern seemed almost insurmountable. Bulk-resistance gages presented a number of problems, chiefly lack of stability. Hydraulic capsules have many attractive characteristics, but if a long tube is used, high-frequency response is difficult to attain.

We decided to work on a capacitance gage and, with the support of the Quartermaster Research and Development Center, pursued that development for more than 3 years. We now have devices called Filpips (Franklin Institute Laboratories pressure indicating patches) which are made of thin embossed steel plates separated by mica (Figs. 3 and 4).

Fig. 3. A Filpip pressure transducer.

A typical Filpip is made of 0.001-inch steel, and seven plates, in an airtight cover, present a total thickness of about 1/32 inch. The change in capacity under load is very substantial, and the auxiliary instrumentation is simple. The devices are flexible and can be used successfully against the body.

These same pressure-sensing elements are also being applied to studies of gait in man; in this case they are placed inside the shoes. Another application of the same technique has been suggested as a means of following, quantitatively, the progress of disease—in this case, one that affects gait.

We have used the same sort of pressure-sensing instrument to evaluate crash-protective helmets, and another group has used it to evaluate protective helmets used in sports. Crash-protective helmets present many interesting bioengineering problems, and a good deal of work has been done in this field. Test procedures have been set up which measure such things as the momentum of a standard projectile which the helmet is able to withstand, the energy of impact of sharp and blunt projectiles which a helmet can absorb without failure, the momentum transmitted through the helmet to a simulated head after a blow. (Devices which project the helmet, pendulums which drop hammers on helmets, and hard steel balls which drop on helmets have been preferred by most experimenters.)

These criteria give a good deal of information about the structure of the helmet and the point at which it fails. However, our interest is not in designing an indestructible helmet but, rather, in designing a helmet which will provide adequate protection against head injury. This, we feel, can best be done by determining the forces and force-time pattern exerted by the helmet on the skull, since, after all, it is the forces on the skull which will cause the injury. We have actually begun applying the aforementioned pressure-sensing elements to a dummy head form covered with a helmet and are using various masses and accelerations to establish force and force-time patterns.

Of course, this neglects one very vital bit of information. We simply do not have data on what forces and force-time patterns the skull can absorb without injury. To this end, we hope to undertake a program that will provide such data. Actually, our plan is concerned less with skull fracture than with brain injury. We propose to insert pressure-sensing instruments inside an animal's skull to measure the effect of various head blows. Measurement of these internal pressures would establish the physical basis of both cerebral concussion and gross brain injury. If such data could be extrapolated to human beings, the bioengineer would be in a good position to design and evaluate crash-protecive gear.

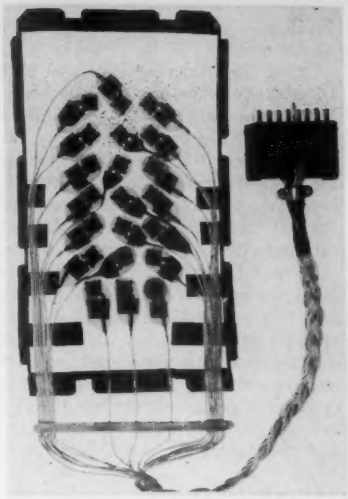


Fig. 4. A Filpip array.

Another application of the pressure-sensing instrument is in measuring the blast forces which are exerted on the body of a pilot who is being ejected from an aircraft at very high speed. These blast forces can cause considerable damage, and it is necessary that they be known and that limits of tolerance be established, so that protective gear can be designed and built.

In addition to the bioengineering problems to which we have applied these Filpips, we have found them useful in other applications. At the moment, for instance, we are measuring aerodynamic pressures of the order of inches of water and are considering applications in heavy machinery where the pressure would go up to many pounds per square inch. The development of these Filpips may serve to illustrate the point that even such a simple problem as a thin, flexible, pressure transducer may require many years of work and a great deal of money, but it is quite possible that the final product of all this effort will have far wider application than was originally intended.

Sensory Substitutes

Fitting the physically handicapped to take useful places in industry is another field of great interest to the bioengineer. Our own experience has been limited to the problems of the blind, but we have developed sensory substitutes which enable blind workers to perform tasks which would not otherwise be possible. Substitutes may range from very complex devices to the very simple, such as a conducting brush and conducting plate used to find holes in a thin mica sheet.

Much more of this kind of thing can and should be done.

Along these lines we expect to begin an extensive program of job engineering for the physically handicapped. Simple devices would be of the type that enables a blind person to read a gage. There are, for instance, many jobs that could be performed by a blind worker except for the fact that a dial must be read. Optical, inductive, or capacitative sensing units could be developed, which the blind worker would apply to the dial face to convert the dial reading to an auditory or tactile signal. In other jobs it is necessary that some mark be made on a record slip, and a simple reading machine might enable the blind worker to locate the proper place to be marked with his number.

Effort Measurement

Studies of the motion and energy expenditures of lower animals and of man may be of considerable interest in designing more efficient techniques of work, in studying disease, and in developing equipment. We have been interested in studies of sleep in human subjects and found it necessary to devise equipment to measure the energy the subject expends during slumber. This may be related to the individual's physical and emotional condition and to the characteristics of the surface upon which he rests as well as to external physical and environmental factors such as temperature and humidity. Since existing equipment could not make these measurements, we have developed special sensing and recording techniques which not only record the frequency of these motions but also integrate energy. In addition, we measure the pressures exerted.

The development of instruments for biomechanical analysis involves many challenging problems. Here we must measure motion and determine velocity and acceleration and a variety of forces and momentums. Such studies are of interest, not only in evaluating prosthetic devices, but also in designing equipment and procedures for use by normal people.

Summary

A tremendous range of physical science problems and techniques, from all branches of engineering, are involved in bioengineering instrumentation. The examples I have cited typify the problems that arise, but the techniques we have used represent only an infinitesimal fraction of the resources that we must exploit. The main challenge to the bioengineer is that of defining the problem in terms of what is useful and economically justified. One must understand the possibilities of engineering development and the probability that an effort will reach any assignable goal within a given time. Only then is it possible to work out a practical solution to the instrumentation problem. It is very easy to become so absorbed in the engineering development that we lose sight of the final goal and the purpose of the development. It is also easy, in working out an experiment, to become obsessed with the need for a particular bit of data, or of too great a degree of precision, without considering that the cost of obtaining these data might not be justified by their value to the full development. Thus, the only principles that can be generally applied to a bioengineering problem are those which would apply to making any decision that leans heavily on judgment.

Biological Clock in the Unicorn

LaMont C. Cole

A physiologist colleague has urged me to examine some of the rapidly accumulating mass of evidence for the existence of rhythms of activity and of various physiological functions. This subject, it seems, is attracting increasing interest among physiologists, and new "cycles" are rapidly being discovered in such remotely related material as intact mammals and slices of living vegetables.

It is postulated that there are two fundamental types of cycles. On the one hand, organisms may exhibit exogenous rhythms and have their periods of activity adjusted to correspond to changes of light intensity, temperature, humidity, phase of the moon, height of tide, or, allegedly, to fluctuations in the intensity of cosmic radiation and of the earth's magnetic field. Presumably, the organisms may respond to several such factors simultaneously so that the raw data from experiments present an appearance of complexity. On the other hand, organisms may possess endogenous rhythms that persist for long periods, if not indefinitely, in the apparent absence of external stimuli. These rhythms may originally have been synchronized with environmental rhythms, but, possibly, some of the endogenous cycles are innate properties of the organisms.

It is not very difficult in theory to conceive of mechanisms for generating persistent rhythms in the absence of external stimuli. For example, a hormone might accumulate until it reaches some threshold value that initiates the activity in question and simultaneously begins to exhaust the store of hormone. It is, however, very difficult to insulate organisms from cosmic radiation and from the earth's magnetic field. Hence, innate rhythms and exogenous rhythms of different periods may be intermingled and lend a further appearance of complexity to the raw data.

Time Series

It would appear that the physiologist faces a major problem of recognizing the cycles in his data and of disentangling the components when several cycles are present simultaneously. Considerable ingenuity has been exercised in the analysis of such data, and the justification for some of the procedures used must lie in some particularly obscure statistical theory. Since this subject seems to be of such current interest, it may be worth while to warn the uninitiated that there is a possibility of being misled in the analysis of complicated time series. This is the purpose of the experiment to be described in the next section.

One approach that could be used for simplifying the experimental data would be to seek correlations between the series of observations and some environmental rhythm. The principal difficulty here is that time series sometimes exhibit the

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perverse behavior of yielding what Yule (*1*) called "nonsense correlations" because no causal connections are apparent. For example, I found a "statistically significant" coefficient of correlation between the growth of Douglas fir trees in Utah and a table of "random sampling numbers" (*2*). Biologists commonly award that certificate of accuracy known as "statistical significance" to any experimental result that has odds of 19 to 1 against its occurrence as a result of chance alone. Consequently, it appears that anyone who has experimental data and sufficient patience to compute different indices and to match these with several independent environmental fluctuations should have a reasonable expectation, in 20 or so trials, of obtaining at least one "statistically significant" result. In computing correlations between independent time series, the odds appear to be a little greater than this in the investigator's "favor." There is, however, a slight problem which is most conveniently ignored; most of the conventional tests of statistical significance involve assumptions that cannot strictly be assumed to hold when one is working with time series (*3*).

Another way of overcoming the consternation one may feel while contemplating complex time series is to "smooth" the data. This is usually done by means of moving averages or comparable devices, and it is certain that this approach does increase the prospect of finding cycles. Slutzky (*4*) showed in 1927 that such smoothing would actually create cycles in random data. The more refined, and arithmetically more difficult, analyses by means of correlelograms and periodograms (*5*) are also known to create cycles in data where none existed before and to be unreliable as devices for finding actual cycles (*6*). One can, of course, resort to harmonic analysis and express any series, even a constant, in terms of cycles, but here the biologist is likely to find the results difficult to interpret.

My previous interest in time series has been confined to the study of the year-to-year fluctuations in the sizes of animal populations (*2*, *7*). Here, the year is a natural unit of time, and it is legitimate to compare population sizes of each year with those of the preceding and following years—that is, time may be treated as a discontinuous variable. This approach, however, is not appropriate for studying hour-to-hour changes in, say, metabolic rate. The hour is an arbitrary unit of time, and an instrument that records amount of activity per hour might indicate differences between two precisely synchronized animals if one always began its activity on the half-hour and the other on the hour. Thus, in analyzing these physiological and behavioral rhythms, we must regard time as continuous in the mathematical sense.

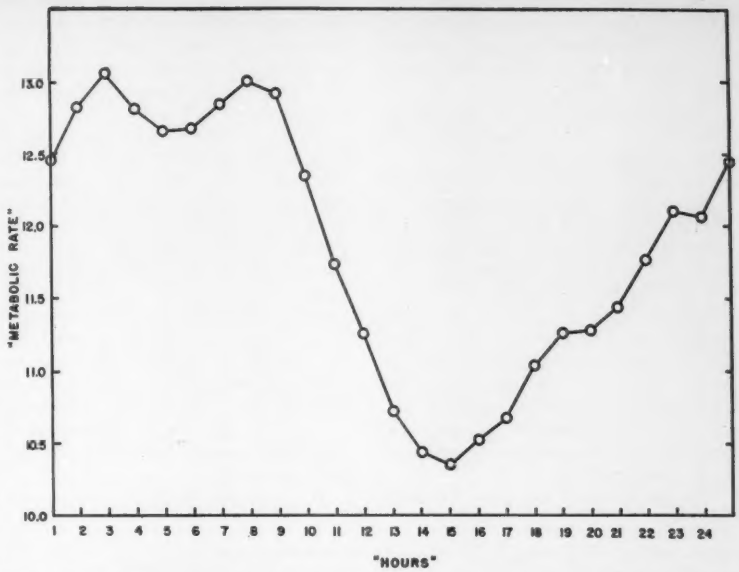

Fig. 1. Cycle of average hourly metabolic rate in a unicorn taken over five consecutive days, with succeeding days retarded 1 hour to allow for change in the time of moonrise.

An Experiment

Now, when we want to decide whether or not a phenomenon is real, a logical procedure is to deduce the results that we would expect to obtain if the phenomenon did not exist. Experimental results can then be compared with the hypothetical results and, conventionally, a result not in accord with the hypothesis of nonexistence of a phenomenon is regarded as evidence in favor of its existence. What we need then is some sort of a "null" hypothesis with which to compare our data on biological rhythms. It would doubtless be possible to attack this problem analytically, but the present study deals entirely with an experimental approach.

Because of the difficulty, already alluded to, of insulating experimental organisms from all environmental rhythms, the experimenter usually must face the possibility that exogenous and endogenous rhythms may be confounded in his results. This difficulty could be eliminated if one could employ an experimental organism that is totally insulated from all exogenous rhythms. The famous unicorn admirably fulfills this criterion and was, therefore, selected as the experimental animal in this study.

It is possible to treat time as a continuous variable by following the amounts of change of activity between hours. The Rand Corporation (*8*) has recently published 100,000 values that seem eminently appropriate for representing the metabolic activity of unicorns. These numbers were obtained by solving for x, the normal deviate, in the equation

$$D + \tfrac{1}{2} = \frac{10^5}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{t^2}{2}}\, dt$$

where D is a five-digit random number from a table that has passed extensive tests for randomness.

In our experimental approach we assume that the unicorn has some "standard" metabolic rate, measured in arbitrary units, and subject to change with time. The average amount of change from hour to hour, when measured over a long time span such as the life of the unicorn, is assumed to be normally distributed about a mean value of zero. In going from one hour to the next, however, the direction and amount of change is assumed to be a random normal deviate.

In our arbitrary units, we assigned the unicorn an initial metabolic rate of 20. Then we started through the table of normal deviates to find the metabolic rates in subsequent hours. In the first hour, for example, the rate was 20–1.276, or 18.724, in the second hour it was 18.724–1.218, or 17.505, and so on. One hundred and twenty consecutive observations of metabolic rate were made in this way. These were taken to correspond to hourly readings over 5 consecutive days.

It seems to be standard procedure in analyzing data on physiological rhythms

to average the corresponding hourly data of several days. We did that in this case and the data seemed to suggest underlying rhythms, but no pattern was clearly apparent.

While contemplating the data, it occurred to me that in summer at 40° north latitude the hour of rise of the moon may be retarded by approximately 1 hour each night. Consequently, to eliminate any such lunar rhythm, we "slipped" the data one hour per day, aligning "hour 1" of the first day with "hour 2" of the second day, with "hour 3" of the third day, and so on. This seems to be a standard sort of procedure for analyzing such data. Now, when the hourly figures for the five days were averaged, a daily rhythm came clearly into focus. This rhythm must have been obscured by the simultaneous presence of the lunar rhythm.

Another standard procedure for analyzing such data consists of smoothing the activity cycles by means of a three-point moving average. Consequently, this was done before graphing the results to produce the representation of unicorn activity shown in Fig. 1.

Figure 1 seems to tell a clear story of an endogenous rhythm. Eliminating the effect of the lunar periodicity shows that the peak of endogenous activity occurs at "3 A.M." and that the minimum occurs exactly 12 hours later. The unicorn obviously tends to be active in the early morning and quiescent in midday. The "midmorning" dip in activity indicated in the figure remains unexplained but may possibly be a subject for future research. It seems almost superfluous to mention that, like other "biological clocks," this rhythm is independent of the temperature at which the observations were made.

This example illustrates some of the possibilities for detecting "cycles" by means of relatively simple arithmetic procedures. A rhythm as definite as that in Fig. 1 could easily be shown to be highly correlated with environmental fluctuations, but the nature of the material employed in this experiment seems to preclude any such causal relationships.

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News of Science

German Physicists Protest Nuclear Weapons

Eighteen leading nuclear physicists in West Germany, four of them Nobel prize winners, have announced formally that they would refuse to cooperate in any way in the production, testing, or use of atomic weapons. In a statement issued through the Max Planck Institute of Physics in Göttingen, the physicists said in part:

"We do not feel competent to make concrete proposals regarding the policy of the great powers [on atomic weapons]. But we believe that a small country like the Federal Republic can best protect itself and help world peace if it expressly and voluntarily renounces possession of atomic weapons of any kind."

On the other hand, the men commented that it is of the utmost importance to develop the peaceful use of atomic energy, and in this they are prepared to cooperate. The signers of the statement acknowledged that they were not politicians but maintained that their scientific work placed upon them the responsibility for the possible consequences of their labor. Therefore, they feel that they cannot remain silent on political questions. The statement concluded with a warning that no technical means have yet been developed to protect large concentrations of people from nuclear warfare.

The Nobel laureates who signed the statement were Otto Hahn, the first physicist to split the atom, Werner Heisenberg, Max von Laue, and Max Born. The other signers, all professors, were Carl Friedrich von Weizsaecker, Fritz Bopp, Rudolf Fleischmann, Walther Gerlach, Otto Haxel, Hans Hopfermann, Josef Mattauch, Freidrich-Adolf Paneth, Wolfgang Paul, Wolfgang Riezler, Fritz Strassman, Wilhelm Walcher, and Karl Wirtz.

The statement, which was released on 12 Apr., had a tremendous impact in West Germany and brought an immediate response from Chancellor Adenauer, whose remarks included the following:

"If these gentlemen intended to advocate a general ban on atomic weapons valid for all countries, it would coincide completely with the views of the Government. . . . If however, they meant to say that . . . the Federal Republic should renounce such weapons, then I must say that this has nothing to do with physical science. That is a purely foreign policy matter." Adenauer also commented that the scientists seemed ignorant of recent United States experiments for protecting against the effects of atomic weapons.

On 14 Apr. five of the 18 physicists, led by von Weizsaecker, categorically rejected the Chancellor's replies. They implied that the government's leaders had deceived the German people about the destructive power of tactical atomic weapons. They repudiated Adenauer's assertion that atomic armament was a political matter for which he, as head of the government, was primarily responsible and contended that they had a duty as citizens to take a stand and warn the people against the dangers of atomic weapons.

The five professors also implied that the Chancellor was guilty of concealing the truth when he indicated that their earlier warning had come as a surprise to him. They said that their views had been transmitted in writing last December to the defense and atomic affairs ministers and that there had been private discussions with these ministers in January.

Hahn, one of the group that made the second statement, explained to the press that the question of atomic armament was a matter of conscience for him. He said that the atomic bomb dropped on Hiroshima in 1945 had made a frightful impression on him and that, as one of the pioneers in atomic research, he felt a certain responsibility for what had happened.

Raise for Britain's Physicians

A 5-percent interim pay rise for general practitioners in Britain's National Health Service went into effect on 1 May. The increase also applies to senior hospital medical and dental staffs, including specialists and consultants. A 10-percent rise was granted earlier to junior staff members. Physicians and dentists in the National Health Service are seeking a 24-percent increase, and the general practitioners have threatened to withdraw from the service this fall.

The interim increases were granted pending a report from a Royal Commission that has been appointed to make a complete review of the service's salary scale. The British Medical Association, which is backing the withdrawal plan, was not mollified by the pay concession. It termed the 5 percent an arbitrary figure decided on by the Government without negotiation or arbitration. The British Dental Association also described the raise as unsatisfactory.

Accreditation of Mouse Producers

The greatly expanded contract program of the Cancer Chemotherapy National Service Center (National Cancer Institute) for the screening of compounds for possible anticancer activity and the increased research grants program of the National Institutes of Health have necessitated a major increase in the production of laboratory mice. The shortage of mice of certain inbred strains has been especially critical, for the transplantable tumors used in the screening program grow only in these particular inbred strains.

For a long time the main source of supply for inbred mice was the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Me. However, the demand for inbred mice exceeded the production capacity of this laboratory. Therefore it became necessary to devise methods by which commercial laboratory mouse producers with no training in the principles of genetics could cooperate with the Jackson Laboratory and other mammalian genetics laboratories in producing an increased number of inbred mice. These methods had to insure the genetic homogeneity of all mice of any specific strain, even though produced at different geographic locations; the methods also had to insure that variability of the mice because of environmental differences would be kept to a minimum.

Following the pioneer work of William Lane-Petter of the Laboratory Animals Bureau in establishing a system of accreditation for commercial laboratory animal producers in Great Britain, the development here of a similar system of accreditation based on a series of animal husbandry and breeding standards, coupled with periodic inspections of accredited producers, seemed to be the best solution to the problem. Such a program has been one of the major aims of the Institute of Laboratory Animal Resources (National Academy of Sciences–National Research Council) since its inception in 1952. The Cancer Chemotherapy National Service Center (CCNSC) therefore requested the Institute of Laboratory Animal Resources (ILAR) to undertake the development of a series of minimum animal husbandry and breeding standards for use in assuring an adequate supply of inbred mice for its screening program.

A series of conferences was held in which members of the ILAR Committee on Standards, ILAR and CCNSC staff members, a number of mammalian population geneticists, and a majority of the commercial laboratory mouse producers cooperated in developing a set of minimum standards which would incorporate the latest scientific requirements and yet be economically practical. Personal visits and discussions by staff members at a representative number of commercial and academic laboratory mouse-breeding facilities, as well as at a number of major laboratories using mice, also aided in making the standards as practical as possible.

Accreditation of commercial breeders of inbred and/or random-bred laboratory mice based on conformity with the *Minimum Standards for the Commercial Production of Random-bred and Inbred Laboratory Mice,* as determined by periodic inspections by a responsible organization, is intended to assure the purchaser that the mice have been produced under good environmental conditions and proper genetic control. Thus variability from either environmental or genetic causes should be minimal in successive lots of random-bred mice from the *same* accredited producer; variability of inbred mice of a specific strain from *any* accredited producer should also be minimal.

The success of this program of accreditation will rest solely upon the cooperation of the commercial laboratory mouse producers and the academic, governmental, and industrial laboratories using mice. As is stated in the preamble to the *Minimum Standards,* it is expected that the standards will be revised from time to time as experience dictates. All suggestions for improving the *Minimum Standards* or any other part of this program will be gratefully received. Copies of the *Minimum Standards* may be obtained from Mr. Berton F. Mill, Executive Secretary, Institute of Laboratory Animal Resources, National Academy of Sciences, 2101 Constitution Ave., NW, Washington 25, D.C., or from Dr. George L. Wolff, Section on Screening, Cancer Chemotherapy National Service Center, National Cancer Institute, Bethesda 14, Md.

The Institute of Laboratory Animal Resources (NAS-NRC) intends to develop similar sets of standards to cover the production of other laboratory animals in the near future. Ten million mice is a conservative estimate of the number used annually in this country by academic, governmental, and industrial laboratories. In view of this preeminent position as an experimental animal in biological and medical research, it is appropriate that the mouse is the first laboratory animal for which such a program of standardization has been developed.

Committee on Standards
T. C. BYERLY, *chairman,*
T. AARONS, R. H. BARNES,
N. R. BREWER, L. R. CHRISTENSEN,
C. N. W. CUMMING, C. L. DAVIS,
R. J. FLYNN, G. E. JAY, JR.,
C. A. SLANETZ, J. E. WILLIAMS

Radio Pill for Studying Gastrointestinal Physiology

A new radio broadcasting capsule which can be swallowed like a medicinal pill was demonstrated recently at the Rockefeller Institute, New York. As it passes through the intestine, this small FM broadcasting transmitter signals the activity of the digestive tract to an outside receiver. The capsule has been developed and tested jointly by the Rockefeller Institute, the New York Veterans Administration Hospital, and the Radio Corporation of America.

This new device for studying the physiology of gastrointestinal pressure was made by Vladimir K. Zworykin, affiliate in biophysics in the institute's Medical Electronics Center and honorary vice president of RCA, and John T. Farrar, chief of the Gastroenterology Section of the New York Veterans Administration Hospital and assistant professor of clinical medicine at the Cornell University College of Medicine. The pill, which was developed by engineers in RCA's commercial electronic products organization in Camden, N.J., is being tested clinically by Farrar and his associates.

In its present stage of development, the capsule must be considered as an experimental technique but one which holds important implications for future medical research. The device is plastic and measures approximately 1⅛ in. long and 4/10 in. in diameter.

The various electronic components of the capsule—transistor, oscillator, a fer-

rite cup inductance core, and other circuit elements—are combined in the center of the pill. Housed in one end is a minute, replaceable storage battery which powers the oscillator. (In World War II this type of battery was used for the VT proximity fuse for antiaircraft shells.) The other end of the capsule is sealed by a flexible rubber membrane. The membrane transmits the body's pressure variations to a diaphragm, which supports the armature of the ferrite cup inductance core. This core contains a coil whose inductance varies with the pressure exerted on the diaphragm. The signal generated by the radio pill, at a frequency of approximately 1 megacycle, varies in frequency as the inductance is varied by changing pressure on the diaphragm.

The radio pill is radiopaque, so its course through the gastrointestinal tract may be traced by fluoroscopy or other means. Since it has magnetic properties, it may be possible to manipulate it by magnetic forces outside the body.

NSF Science Faculty and Senior Postdoctoral Awards

The National Science Foundation has announced the award of 100 science faculty fellowships in the sciences for 1957–58. Awarded this year for the first time, these fellowships are offered as a means of improving the teaching of science, mathematics, and engineering in American colleges and universities.

Science faculty fellows were selected from 416 applicants from all parts of the continental United States and its territories on the basis of ability as indicated in letters of recommendation, academic and professional records, and other evidence of attainment and promise. Eligibility requirements included a baccalaureate degree or its equivalent, demonstrated ability and special aptitude for science teaching and advanced training, and 3 years of full-time science teaching at the college level.

The foundation has also announced the award of 30 senior postdoctoral fellowships in the sciences for 1957–58, selected from 168 applicants. These fellowships were awarded to scientists of demonstrated ability and special aptitude for productive scholarship in the sciences. Sixteen awards were made in the life sciences and 14 in the physical sciences, including a number in interdisciplinary fields.

Science faculty and senior postdoctoral fellowships carry stipends adjusted to approximate the regular salaries of award recipients. These stipends may be applied toward study or research in an accredited nonprofit institution of higher learning in the United States or abroad.

Grace Nuclear Fuel Plant

W. R. Grace and Company, New York, has announced that construction will begin immediately on a plant to produce basic raw materials for nuclear reactor fuel. The plant will be located at Erwin, Tenn., and is designed to produce uranium, thorium, and rare-earth alloys and metals for reactors now in use or under construction by both private enterprise and defense units. Other than uranium, thorium is the only naturally occurring element that can be converted into fissionable material. The plant is perhaps the first of its kind financed and operated entirely by private enterprise.

The installation will consist of a solvent extraction plant producing pure thorium and uranium salt, a reduction plant that will convert the salt to metal powder or sponge, and a melting and casting plant containing both vacuum-induction and arc-melting facilities. The thorium metal produced probably will find extensive use in magnesium alloys for jet aircraft and guided missiles.

The new plant is expected to employ initially 50 to 60 people. It will be operated under the supervision of F. C. Nicholson, vice president for chemical operations of the Davison Division. Directly in charge of the plant will be T. C. Runion, general manager for nuclear reactor materials.

Cullen Engineering College at Houston

The University of Houston has received gifts totaling $6.5 million for the construction of the Cullen College of Engineering building and for creating six chairs for distinguished professors. A gift of $5 million for the building came from Mr. and Mrs. Hugh Roy Cullen, through their Cullen Foundation. The gift brings to about $30 million the total of the Cullen gifts to the university. The M. D. Anderson Foundation gave the school $1.5 million for the six professorships.

Soviet Scientists Cancel U.S. Visit

Six Soviet scientists who had accepted invitations to the recent seventh annual Rochester Conference on High Energy Nuclear Physics did not attend. A last-minute cablegram received by the University of Rochester, host to the conference, said: "Regret U.S.S.R. Academy of Sciences delegation will not attend Rochester conference due to technical reasons. Best wishes for conference success."

Among the Russian delegates who had been expected was D. I. Blokhintsev, a director of the Joint Institute of Nuclear Problems in Moscow. Two non-Russian directors of the institute attended the conference. They were Marian Danysz of Warsaw, Poland, and Vazlav Vortruba of Prague, Czechoslovakia. Six other scientists from Poland also participated in the meeting.

Kelco Research Laboratory

The Kelco Company, large producer of algin products widely used as thickening, suspending, stabilizing, emulsifying, film-forming, and gel-producing agents, has announced construction of a new $250,000 research laboratory in Research Park, San Diego, Calif. The primary purpose of the new facilities is to provide advanced technical service in the solution of the product and processing problems of the company's clients in the dairy, food, textile, chemical, paper, plastics, beverage, paint, drug, and cosmetic industries.

National Bureau of Standards, 1956

The 1956 annual report of the National Bureau of Standards is now available at the U.S. Government Printing Office, (Washington 25, D.C.). This 158-page publication summarizes the bureau's research and development activities in the physical sciences during the last fiscal year. Brief descriptions are given of representative accomplishments in each area of the bureau's responsibilities, which include maintenance of basic standards, determination of physical constants and properties of matter, development of methods and instruments of measurement, and the provision of calibration, testing, and scientific advisory services.

During the past year, significant results were achieved in programs dealing with electronic computers, electronic instrumentation, and the properties of matter and materials. A new high-speed computer that provides the geographic fallout pattern after a nuclear explosion was developed for the the Atomic Energy Commission. Development work was successfully completed on a microimage data storage and retrieval device, which provides rapid access to any one of 10,000 microfilmed images located on a 10-inch-square sheet of film.

The bureau also developed a technique for capturing and storing large numbers of free radicals—highly reactive molecular fragments—at temperatures near absolute zero. In the field of optics and metrology, the bureau completed a comprehensive dictionary of color names, which lists some 7500 individual color names and defines them in simple accurate terms easily understood by workers

in different fields. A study of the effect of crystal orientation of fatigue crack initiation in metal was also completed.

The annual report is composed of five sections: a general review or summary, a résumé of the bureau's research and development work in progress or completed during 1956, a review of the testing and calibration program, a discussion of the bureau's various cooperative activities, and an appendix consisting primarily of statistical and organizational material and a complete list of publications by NBS staff members for the fiscal year.

May Scientific Monthly

Articles appearing in the May issue of *The Scientific Monthly* are "Changing Energy Scene," C. A. Scarlott; "Livestock Parasites and Grass," B. Schwartz and H. H. Vegors; "Global Distribution of Strontium-90 from Nuclear Detonations," M. Eisenbud; "Man's Place in Living Nature," H. J. Muller; "Canalization of the Moselle," W. E. McIntyre. Nine books are reviewed.

Scientists in the News

HERBERT S. GASSER of the Rockefeller Institute of Medical Research will deliver the annual Hughlings Jackson memorial lecture on 15 May at the Montreal Neurological Institute, Montreal, Canada. He will discuss "The properties of unmedulated nerve fibres with afferent function."

ROBERT W. WHITE, chairman of the department of social relations at Harvard University, will deliver a public lecture on 10 May at the New York Academy of Medicine on "Adler and the future of ego psychology." The occasion of the address will be the commemoration of the 20th anniversary of the death of Adler on 28 May 1937.

L. SIMINOVITCH of the Connaught Medical Research Laboratories, University of Toronto, has received the Ross G. Harrison prize of the International Society for Cell Biology. The award consists of a travel grant of $750 for attendance at the International Congress of Cell Biology.

FRANK J. DIXON, professor of pathology and chairman of the department in the University of Pittsburgh School of Medicine, has been awarded the first national Parke-Davis award in experimental pathology for "his original and meritorious work" in the field. He received the $1000 prize and a bronze plaque at the recent meeting of the American Society for Experimental Pathology in Chicago, Ill. The society is the administrator of the award. Dixon won the AAAS Theobald Smith award in 1952.

S. MARSH TENNEY, formerly associate professor of physiology and medicine at the University of Rochester School of Medicine and Dentistry, has been appointed professor of physiology and chairman of the department of physiological science at Dartmouth Medical School. In addition, he is the college's associate dean in charge of research and planning.

ROBERT GOSSELIN, also formerly of Rochester, where he was assistant professor of pharmacology, has been appointed professor of pharmacology at Dartmouth.

PETER HIDNERT, well-known specialist in the field of thermal expansion, retired on 31 Mar. after 45 years of service at the National Bureau of Standards. He has been active in the study and development of low-expanding alloys and thermostatic devices depending on thermal expansion. His studies of the structural changes occurring in metals under varying temperature conditions have been of particular importance in developing high-temperature, high-strength alloys used in jet and rocket engines.

Hidnert joined the NBS staff in 1912 as a laboratory apprentice. He started his work in thermal expansion in 1916 and in 1946 was made chief of the thermal expansion section. Hidnert was awarded his A.B. degree in physics from George Washington University in 1918 and his M.S. degree in 1919. He took his doctorate in physics at American University, where he received his degree in 1931.

DICKINSON W. RICHARDS of Columbia University College of Physicians and Surgeons, who last fall was one of the three winners of the Nobel prize in medicine and physiology, will deliver the fifth annual Dakin memorial lecture at Adelphi College on 8 May.

The new appointments to the staff of the National Science Foundation have been announced: WILLIAM B. COOK will be associated with the Summer Institutes Program in the Division of Scientific Personnel and Education; and ROBERT L. BUTENHOFF has been appointed program director, Scientific Communication Systems, in the Office of Scientific Information.

Cook is on leave of absence from Baylor University, where he has been professor of chemistry since 1953.

Butenhoff will be responsible for coordinating arrangements for United States participation in the Brussels World's Fair—1958. The foundation has been charged with developing and carrying out the American science program to be presented at the fair. Butenhoff has been with the U.S. Atomic Energy Commission since 1949 as chief of the radiation instruments branch of the Division of Biology and Medicine.

I. BERNARD COHEN, associate professor of the history of science and general education at Harvard University, has been awarded the $500 book prize of the Institute of Early American History and Culture. The prize, given annually for the best book published in the field of early American History, will be presented to Cohen on 4 May at the yearly meeting in Williamsburg, Va., of the institute's council. The institute is devoted to research and publication in early American history and is sponsored jointly by the College of William and Mary and Colonial Williamsburg.

Cohen is being honored for his study on *Franklin and Newton, an Inquiry into Speculative Newtonian Experimental Science and Franklin's Work in Electricity as an Example Thereof*. The work was published this year by the American Philosophical Society as volume 43 of its "Memoirs."

CHARLES G. DODD, formerly of Lehigh University, has been named Halliburton professor of petroleum engineering at the University of Oklahoma.

J. FREDERIC WALKER of the DuPont Company's Electrochemicals Department, Niagara Falls, N.Y., has been selected to receive the 1957 Jacob F. Schoellkopf medal of the Western New York Section of the American Chemical Society. He will be honored for his outstanding contributions to the chemistry of formaldehyde. The medal will be presented at the annual Schoellkopf Award Meeting at the Sheraton Brock Hotel, Niagara Falls, Ont., on 14 May.

Sister MARY JOHN, chief pharmacist at Mercy Hospital, Toledo, Ohio, is the recipient of the 1957 Harvey A. K. Whitney award of the Michigan Society of Hospital Pharmacists. She has been chief pharmacist at Mercy for 17 years.

JAMES B. EVANS, bacteriologist with the American Meat Institute Foundation, Chicago, Ill., for the last 9 years, has been appointed chief of the division of bacteriology. In addition, J. WALTER GIFFEE, formerly assistant chief of the radiation preservation branch of the Quartermaster Food and Container Institute, has joined the foundation as chief of the division of hide research.

Evans succeeds CHARLES F. NIVEN, JR., who was named associate director of research and education last November; Giffee succeeds FRANK L. LEBEUKELAER, former chief of hide research, who has retired and is living in Florida.

IVAN D. BARONOFSKY has been appointed director of the department of surgery at the Mount Sinai Hospital of New York. In February he completed a 2-year tour of duty as chief, Thoracic Surgery Service, Naval Hospital, San Diego, Calif. Before that, he was associate professor of surgery and director of the department of postgraduate surgery, University of Minnesota Medical School; director, postgraduate surgery education, Ancker Hospital, St. Paul; and staff surgeon, University Hospital, Minneapolis.

BUELL W. BEADLE has been appointed manager of the chemistry division at the Midwest Research Institute. He succeeds JOHN T. GOODWIN, JR., who resigned to become technical director of the Corn Industries Research Foundation, Washington, D.C. Beadle was formerly on the staff of the Southwest Research Institute, San Antonio, Tex., where he was chairman of the department of chemistry and chemical engineering. In his new position, he will head a staff of 50 research chemists.

EMERSON DAY, director of the Strange Cancer Prevention Clinic of the Memorial Center for Cancer and Allied Diseases, New York, has received the annual bronze medal of the New York City Cancer Committee of the American Cancer Society "in recognition of his distinguished service in the field of cancer detection and control." Day, who has been vice president and director of the committee since 1950, also is chief of the Division of Preventive Medicine at the Sloan-Kettering Institute.

JOHN BURR, formerly a senior chemist at Oak Ridge National Laboratory, has joined Atomics International, a division of North American Aviation, where he has been named supervisor of the radiation chemistry unit.

ROMAN SMOLUCHOWSKI, professor of physics and metallurgical engineering at Carnegie Institute of Technology, has been invited to give a series of lectures in July at the International Summer School on Solids in Varenna, Italy. Internationally known for his work in solid-state physics and physics of metals, Smoluchowski has been working for more than 5 years on the effects of irradiation in atomic reactors for the U.S. Atomic Energy Commission.

DAVID ATLAS has been selected as Guenter Loeser memorial lecturer for 1957 by the Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass. Atlas will speak on "Progress and prospects of radar meteorology" on 23 May in the New England Mutual Building, Boston, Mass. The Loeser lecture is given at intervals of 1 year or more by a scientist of the Geophysics Research Directorate who is nominated in recognition of outstanding achievement in research.

GEORGE M. DARROW, founder of research on small fruits in the U.S. Department of Agriculture, retired from the department on 31 Mar. after 46 years of government service. Darrow is widely recognized for his work in originating a number of different high-yielding strawberry varieties and in helping to make possible the commercial production of blueberries in the United States through cross-breeding and selection of wild varieties of this fruit.

He is credited with the development, through his own efforts and in cooperation with state agricultural experiment stations and industry plant breeders, of 23 varieties of strawberries, including 10 that are of current commercial importance. One, the Blakemore strawberry, is now produced on about 30 percent of the commercial acreage in this country. Darrow received USDA's Distinguished Service award in 1954 for his achievements in horticultural research.

He is continuing as a consultant to the Crops Research Division of the USDA Agricultural Research Service. This year he will assist his successor, D. H. SCOTT, in the selection of new and promising varieties of blueberries at the USDA Agricultural Research Center, Beltsville, Md.

Darrow received the A.B. degree in horticulture from Middlebury College in 1910 and his A.M. degree from Cornell University in 1911. He obtained his doctorate at Johns Hopkins University in 1927.

In 1948 he was awarded the Wilder medal for "leadership in the development of small fruit and in the origination of meritorious varieties." He is a past-president of the American Society for Horticultural Science and of the Washington (D.C.) Botanical Society. He has served on the editorial board of the American Genetic Association since 1923.

JOHN A. KING, industrial research chemist, has been appointed director of research for Armour and Company, Chicago, Ill.

THOMAS G. FOX, polymer chemist who is at present in the research department of the Rohm and Haas Company, Philadelphia, Pa., has been appointed an assistant director of research at the Mellon Institute, Pittsburgh, Pa., effective 1 June. He will head Mellon's polymer research programs.

JOHN A. HRONES, mechanical engineer and director of the Dynamic Analysis and Control Laboratory at Massachusetts Institute of Technology, will join the staff of Case Institute of Technology on 1 July as vice president for academic affairs. The position is a newly created one designed to provide increased coordination of all educational and research activities in the fields of science, engineering, and management.

ROBERT F. SMART, professor of biology and chairman of the division of sciences and mathematics at Richmond College has succeeded the late Raymond B. Pinchbeck as dean of the college.

Recent Deaths

ADAM G. BÖVING, Washington, D.C.; 87; associate of the Smithsonian Institution; former senior entomologist of the Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture; 16 Mar.

THOMAS M. BRENNAN, Brooklyn, N.Y.; 72; surgeon; formerly professor of operational surgery at the Long Island College of Medicine; 11 Apr.

BRADLEY M. DAVIS, Portland, Ore.; 76; head instructor at the Marine Biological Laboratory; 13 Mar.

FREDERICK B. FLINN, New York, N.Y.; 80; retired physiologist, industrial toxicologist, and associate professor of industrial hygiene at the College of Physicians and Surgeons, Columbia University; 8 Apr.

RANSOM S. HOOKER, Charleston, S.C.; 83; former director of surgery at Bellevue Hospital who also had been associate professor of surgery at the College of Physicians and Surgeons, Columbia University; 11 Apr.

FREDERICK KETTNER, Cleveland, Ohio; 71; founder-president of the Biosophical Institute; 28 Mar.

THORVALD MADSEN, Copenhagen, Denmark; 87; Danish bacteriologist who was director of Denmark's Serum Institute from 1902 to 1940; 15 Apr.

FRANK M. SIMPSON, Lewisburg, Pa.; 84; professor of physics, emeritus, at Bucknell University; 10 Apr.

JOSHUA E. SWEET, Unadilla, N.Y.; 80; retired professor of surgical research at Cornell Medical College; 8 Apr.

JAMES VAUGHN, Cincinnati, Ohio; 59; professor of psychology in the McMicken College of Arts and Sciences at the University of Cincinnati; 10 Apr.

Reports

Probable Role of Gamma Irradiation in Origin of Life

This article (*1*) reports the production of simple organic compounds, including at least one and possibly two amino acids, from ammonium carbonate by gamma irradiation from a cobalt-60 source. To our knowledge, this is the first instance in which amino acids have been obtained directly from completely oxidized forms of carbon in the absence of free hydrogen. In our opinion, gamma irradiation from terrestrial sources is a much more probable agent than lightning and sunlight for the generation of most of the so-called "organic milieu," the nonliving mixture of carbon compounds which is generally considered to be a prerequisite for the origin of life.

Löb (*2*) in 1913 appears to have been the first to obtain evidence of an amino acid after subjecting CO, NH_3, and H_2O to a silent electric discharge. Miller (*3*) recently greatly extended such experiments by using NH_3, H_2O, H_2, and CH_4; he obtained a wide variety of organic substances. Abelson (*4*) has confirmed this work while using CO and CO_2 in place of CH_4. Calvin and coworkers (*5*) irradiated a variety of simple compounds with helium ions and with ultraviolet light and obtained more complex substances. Quite recently Hasselstrom, Henry, and Murr (*6*) formed amino acids from ammonium acetate by means of an electron accelerator. Oparin (*7*) has proposed that hydrocarbons arose from the polymerization of acetylene which formed from the reaction of water with metallic carbides.

In our experiments, 45-g quantities of ammonium carbonate (lumps, Mallinkrodt A. R.) were sealed under water-pump vacuum (approximately 7 mm Hg) in two glass ampules (outside diameter, 25 mm). Each ampule was irradiated with gamma rays from a 4000-c cobalt-60 source for approximately 15 days to give dosages of 500 ± 15 Mrep. After irradiation, the ampules were opened and subjected to water-pump vacuum while they were immersed in a steam bath. Under these conditions, all ammonium carbonate was vaporized in about 5 hours. Volatile organic compounds also were removed. The residue, approximately 0.2 g, consisted of about equal quantities of a sublimate of large cubical crystals at the top of the ampule and a white powder at the bottom.

Infrared spectra of pressed KBr plates showed the sublimate (m 108° to 110°C uncorrected) to be ammonium formate. The white powder was apparently too complex a mixture to permit any positive identification. Paper chromatography of the powder, however, showed the presence of glycine, ammonium formate, possibly alanine, and an unknown, more slowly moving substance that also gave a positive ninhydrin test. Lack of material did not permit positive identification of alanine. Glycine was identified in five solvent systems: 77 percent ethanol; 80 percent pyridine; phenol buffer at pH_{12}; *sec*-butanol and 3 percent NH_4OH (3/1); and *n*-butanol, acetic acid, and water (4/1/5). In the first four systems, the R_f value for the unknown was identical with that of known glycine. In the last system, the R_f was slightly less than that of pure glycine, but this was shown to be due to the presence of ammonium formate in the unknown. Controls run in the same manner but not irradiated gave a barely discernable residue and negative ninhydrin tests of the water solution.

It is not known whether the massive dose used (500 Mrep) is necessary. The important fact is that amino acids were formed from ammonium carbonate.

Ionizing radiation can, of course, cause the destruction of organic compounds as well as their formation. One can assume, therefore, that organic substances would not concentrate on even a sterile earth unless some great shield were available to protect them once they formed. The seas could be this shield. Inorganic and simple organic compounds on or close to radioactive sources, especially gamma emitters above or below the sea, could be transformed into amino acids. These amino acids, with the help of rain and ocean currents, could migrate to dark, nonradioactive areas where, as suggested by Bernal (*8*), they could be accumulated and oriented by adsorption on clays or quartz (as sand).

There appears to be little doubt that enough radioactivity to accomplish such reactions existed after the earth had cooled sufficiently to permit condensation of the water vapor to form the oceans. An upper limit on the irradiation time may be obtained if it is assumed that the terrestrial radioactivity was the same as it is today. Indeed, if we consider only the three major series (U^{238}, 4.5×10^9 yr; Th^{232}, 13.9×10^9 yr; and U^{235}, 0.7×10^9 yr) (*9*), allowances for decay would not result in significantly greater magnitudes. High-activity ores existing today could deliver the necessary radiation doses in tens of years.

No doubt amino acids are being formed by physical processes even today. However, they or the rest of the physically formed organic milieu can no longer accumulate as they did in a sterile world. The present bios zealously guards its birthright and quickly devours any molecules that could give rise to a contender.

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7 March 1957

Variation in Normal Sodium, Potassium, and Calcium Levels in Wistar Albino Rats

In the last decade there has been a marked increase in the use of flame spectrophotometry for physiological studies of electrolyte changes in tissue fluids. As a rule, small numbers of control animals have been used since most studies are predicated on the belief that electrolyte concentrations in the blood normally

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* **125**, 16 (4 Jan. 1957).

Table 1. Morning-evening and day-to-day comparison of serum ion levels (milliequivalents per liter) in male SF-Wistar rats. All dates are 1955; "CV" represents coefficient of variation.

Expt. No.	Date bled	Time	N	Body wt. ($g \pm \sigma$)	Sodium $\bar{X}$	Sodium σ	Sodium CV	Calcium $\bar{X}$	Calcium σ	Calcium CV	Potassium $\bar{X}$	Potassium σ	Potassium CV
1	6 May	11 a.m.	11	281 ± 31	153.3	1.8	1.2	5.43	0.30	5.5	6.50	0.50	7.7
2	6 May	11 p.m.	11	294 ± 28	156.4	1.4	0.9	5.23	0.18	3.4	5.83	0.50	8.5
3	17 May	11 a.m.	12	195 ± 12	157.3	1.9	1.2	5.14	0.17	3.3	6.02	0.44	7.3
4	17 May	11 p.m.	10	189 ± 14	159.6	2.2	1.4	5.21	0.18	3.4	5.48	0.26	4.7
5 (Total)		11 a.m.	23	236 ± 10	155.4	2.7	1.7	5.28	0.28	5.3	6.32	0.58	9.2
6 (Total)		11 p.m.	21	239 ± 12	157.9	2.4	1.5	5.22	0.18	3.4	5.66	0.43	7.6

remain stable within fairly narrow limits. For some time it has been appreciated that the functions of many organs undergo diurnal variation, but only recently has attention been focused on the fact that marked changes in serum constituents also occur (*1–3*).

This report (*4*) is concerned with flame spectrophotometric determinations of serum sodium, potassium, and calcium levels in normal rats and includes data on day-to-day and diurnal variation of these ions. The first phase of the study involved the determination of the normal range of variation of serum sodium, potassium, and calcium in the Wistar albino rat. Animals of comparable age and weight were ordered from two separate supply houses (designated CF- and SF-Wistar rats) to check on possible differences in ion levels of inbred rat strains that presumably came from the same original stock. Blood samples from CF-Wistar rats were taken from 1 to 3 P.M. each day; SF-Wistar rats were sampled at random intervals mornings and afternoons. All ion analyses were made using the Beckman model DU flame spectrophotometer with photomultiplier attachment. The analytic procedure was that described by Kingsley and Schaffert (*5*). The procedure for collecting tail blood samples is similar to that described by Halberg (*1*), and the routine of preparing serum samples was rigidly standardized to minimum variation due to hemolysis or the influence of exposure of blood to air during collection of samples. The degree of hemolysis was checked with a hand spectroscope.

The distribution curves for all three ions in CF-Wistar rats compared well with hypothetical "normal" curves, the means and medians coinciding in every case, and about 70 percent of the values falling within the mean ± 1 standard deviation. Mean values and standard deviations from 109 serum determinations, in milliequivalents per liter, were as follows: 151.0 ± 4.4 for sodium; 5.54 ± 0.62 for potassium; and 4.93 ± 0.27 for calcium. The coefficients of variation were 2.9, 11.2, and 5.4 percent for sodium, potassium, and calcium, respectively.

Normal distribution curves for the same ions were also obtained in the blood serum of SF-Wistar rats. However, the mean levels of the ions were found to be significantly higher than those in the CF-Wistar group. Mean ion values (milliequivalents per liter) with the standard deviations from 72 serum samples of SF-Wistar rats were as follows: for sodium, 157.2 ± 4.2; for potassium, 6.11 ± 0.56; for calcium, 5.41 ± 0.30. The coefficients of variation were 2.7 percent for sodium, 9.1 percent for potassium, and 5.5 percent for calcium.

It was next decided to establish whether the time of blood sampling is important when serum ion analyses are made. Approximately 48 SF-Wistar male rats were used in this study. A shipment of 24 rats was divided into two equal groups, one to be bled at 11:00 A.M., the other at 11:00 P.M. of the same day. A second shipment of the same strain of rats was obtained a week later, and the same procedure of blood sampling was followed. Table 1 summarizes ion data obtained from 44 serum samples, and Table 2 shows the results of an analysis of the data using Fisher's *t* test. It was found that serum sodium concentrations were significantly lower at 11:00 A.M. than at 11:00 P.M. Conversely, potassium levels were higher in the morning. Mean levels of calcium, on the other hand, were not affected by taking blood at different times of the day.

It was further found that the levels of serum sodium from rats bled on 17 May 1955 were significantly higher, and the potassium concentrations lower, than the levels of these ions in rats bled at corresponding times on 6 May 1955. The results suggest that day-to-day fluctuations in serum ions may also be present. Similar results were obtained for serum sodium and potassium when ion data of CF-Wistar rats was analyzed on a day-to-day basis. Serum sodium values of 24 rats bled on four separate days at weekly intervals gave means plus or minus standard errors as follows: 152.0 ± 0.9, 146.6 ± 0.6, 149.0 ± 0.5 and 154.8 ± 0.7 milliequivalents/lit. Corresponding potassium levels on the same days were 5.59 ± 0.08, 5.77 ± 0.12, 5.55 ± 0.12 and 5.27 ± 0.16 milliequivalents/lit.

Statistical analysis of the data on CF-Wistar rats by separation into sexes and weight groups showed no significant differences in serum ion levels of male and female rats.

The extent of variation in ion concentrations in the CF-Wistar strain of rats is similar to that reported by Elliott and Holley (*6*) in a study of 400 normal human subjects. Values reported by these investigators were used as an index of expected variability because a search of the literature failed to bring to light any flame photometric studies of normal ion variation in laboratory animals. The mean sodium and potasium values of CF-Wistar rats are somewhat higher than those reported by Albritton (*7*) but agree closely with values reported by Bernstein (*8*). The SF-Wistar strain, however, showed consistently higher sodium and potassium values, suggesting the presence of intraspecific strain differences in the levels of these ions.

The data seem to indicate that a part of the serum ion variability, especially with sodium and potassium, may be the result of diurnal variations of these ions. Likewise, day-to-day variation in ion levels must also be considered as a possible factor contributing to normal ion variability. It should be recalled in this connection that diurnal fluctuations in other serum constituents have already been amply demonstrated, notably with respect to leucocytic blood components, serum iron, hemoglobin, and serum proteins (*1, 3, 9*). With the greater precision now possible with current spectrophotometric techniques, it should not be surprising to find diurnal variations in serum electrolytes.

Although no conclusions could be drawn from the present study about the mechanisms underlying diurnal or daily ion variation, it was felt that the ob-

Table 2. Statistical analysis of serum ion data; *P*, probability; d.f., degrees of freedom. The numbers in column 1 refer to the experiment numbers in column 1 of Table 1.

Comparison	Sodium *t*	Sodium d.f.	Sodium *P*	Calcium *t*	Calcium d.f.	Calcium *P*	Potassium *t*	Potassium d.f.	Potassium *P*
Experiments 1 and 2	4.32	20	< 0.01*	1.80	19	≈ 0.10	3.06	20	< 0.01*
Experiments 3 and 4	2.51	20	≈ 0.02*	0.89	20	≈ 0.40	3.31	19	< 0.01*
Experiments 5 and 6	3.14	42	< 0.01*	0.83	41	≈ 0.40	4.20	41	< 0.01*
Experiments 1 and 3	5.03	21	< 0.01*	2.74	21	< 0.01*	2.61	21	≈ 0.02*
Experiments 2 and 4	3.77	19	< 0.01*	0.24	18	> 0.50	2.00	18	≈ 0.05*

* Significant using Fisher's *t* test.

served changes could not be ascribed to either technical errors or to disturbances of rats by extraneous laboratory noises. Potential errors in analytic technique were eliminated by routinely running calibration checks on freshly prepared standards. Noise was eliminated as a factor on the basis of other experiments in our laboratory where no differences were found between ion levels of rats that were exposed to noises approximating jet-engine intensity levels and ion levels of nonexposed controls. In the latter studies, significant day-to-day fluctuations in serum sodium and potassium occurred although the means, standard deviations, and coefficients of variation were the same in noise-exposed and control rats bled at corresponding times on any one day.

The net effect of these investigations points to the need for considering diurnal and day-to-day variations in serum ions when dealing with electrolyte changes in animals. Rigid standardization of the time of sampling is mandatory in experiments when small numbers of animals are used to establish "normal" ion levels and when the interpretation of electrolyte shifts is predicated on the assumption that such levels represent a stable base line.

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Preparation of Growth Hormone from Pituitaries of Man and Monkey

Despite occasional suggestions of effectiveness (*1*), growth hormone prepared from the pituitaries of slaughterhouse animals has thus far been generally ineffective in man. Preliminary tests by Beck and Venning (*2*) have shown pronounced anabolic effects in man with growth hormone extracted from human and from simian pituitaries, and we wish to record the method of preparation of the materials used in these tests (*3*). The preparation from monkey was also found by Knobil, Wolf, and Greep to be effective when it was tested in monkeys, although bovine and porcine preparations were inert in that species (*4*).

Table 1. Weight yield of various fractions during preparation of growth hormone from pituitaries of three species. Human and monkey pituitaries were used as obtained, without removal of posterior lobe; the pig preparation was made from anterior lobes only. The values cited were obtained from human pituitary batches of 11.25 g and 24 g of acetone-dried powder, two batches of monkey pituitaries (20.8 and 13 g of powder) and many batches of pig pituitaries.

	Man		Monkey	Pig
	Batch 1 (%)	Batch 2 (%)	(%)	(%)
Acetone-dried pituitary powder	100	100	100	100
Acetone precipitate from glacial acetic extract	4.5	5.4	7.2	7.0
Ether precipitate—"crude extract"	9.4	13.2	20.6	12.0
Adsorbed by oxycel—"corticotropin fraction"	0.16	0.26*	0.14	0.24
Second oxycel adsorption	0.12	0.4*	0.26	0.20
Precipitate at *p*H 8.5	3.12	4.6	7.2	~7.0
Alcohol precipitate—"growth hormone"	3.1	4.6	3.0	1.5

* Double amounts of oxycel were used with batch 2.

The human pituitaries were collected post-mortem and stored in acetone after the amount necessary for microscopic study had been removed (*5*). The activity of the growth hormone survived the delay between death and autopsy, in agreement with observations on the survival of activity in animal pituitaries (*6*). The pituitaries from monkeys were collected in the laboratories of several pharmaceutical companies from rhesus monkeys used in the preparation of poliomyelitis vaccine and were stored frozen (*7*).

Acetone-dried pituitary powder was prepared by homogenization in acetone with a Virtis 45 or Waring Blendor, further washing with acetone on a sintered-glass filter, and desiccation in a vacuum. Growth hormone was extracted and purified by the method originally devised for porcine glands (*8*). The procedure involved extraction with glacial acetic acid at 70°C, removal of an acetone precipitate, precipitation of a crude fraction with ether, removal of corticotropin and intermedin from a weak acetic acid solution with 11 percent COOH oxycellulose (*9*), removal of a *p*H 8.5 precipitate, and precipitation of growth hormone with ethyl alcohol. The weight yield from pituitaries of man and monkey was greater than the yield from pituitaries of pig (Table 1). The activity per unit weight as assayed in the hypophysectomized rat was approximately the same for the three species, with the human material perhaps slightly more active, and the monkey slightly less active, than the pig. It is assumed that the product is chemically impure, in view of the recent finding that animal growth hormone prepared by this and other methods can be further fractionated chromatographically (*10*).

Certain features of this method of preparation of growth hormone made it particularly suitable for its present use. Storage of the human pituitaries in acetone simplified the collection of glands, treatment of the pituitary powder with acetone, ether, and hot glacial acetic acid provided strong bactericidal and viricidal action in the extraction of human pituitaries of indeterminate origin, and the virtual absence of thyrotropin, as well as the low degree of contamination with other pituitary hormones, made the final product well suited for clinical use.

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3 MAY 1957

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Metabolic Effects of Human and Monkey Growth Hormone in Man

The growth-promoting activity of crude anterior pituitary extracts was first demonstrated by Evans and Long in 1921 (*1*). Li and his associates (*2*) isolated and characterized the properties of the hormone responsible for this effect in 1944 and summarized the diverse physiological effects observed in animals in 1951 (*3*). Wilhelmi, Fishman, and Russell in 1948 (*4*) and Raben and Westermeyer in 1951 (*5*) developed procedures for crystallizing growth hormone in good yield, permitting wider exploration of its metabolic effects in animals and man. While previous work in animals was confirmed and elaborated using these preparations, the data on the effects in man, particularly with regard to its protein anabolic action and its influence on carbohydrate metabolism, are at best inconclusive (*6*).

Shorr and his associates (*7*), using growth hormone prepared according to the method of Wilhelmi *et al.*, in two female subjects of short stature, showed some enhancement of nitrogen, calcium, and phosphorous storage as well as impairment of glucose tolerance and increased insulin resistance. The same report included data on three males of short stature who failed to exhibit any metabolic response to growth hormone. In addition, Knobil (*8*), in a study of these preparations in the normal and in the partially pancreatectomized rhesus monkey, failed to elicit any physiological effect. Wilhelmi (*9*) and Knobil (*10*) suggested that the failure to demonstrate significant and consistent metabolic effects in the rhesus monkey and in man with preparations of bovine growth hormone might be the result of species differences in the growth hormone. Support for this concept was provided by the further work of Knobil (*11*), who found monkey growth hormone to be metabolically active in monkeys. This preliminary report deals with some of the metabolic effects observed in a human pituitary dwarf during the administration of human and monkey growth hormone prepared by Raben (*12*).

A 13-year-old male with well-documented hypopituitarism secondary to a craniophyaryngioma was studied on the metabolic ward of the Royal Victoria Hospital in Montreal, Quebec. Replacement therapy from May 1952 to April 1956 had consisted of methyl testosterone administered intermittently with resultant growth in height and maturation of skeletal age. This therapy also resulted in moderate genital maturation and the development of sparse axillary and pubic hair. For the immediate four months prior to this study, daily replacement therapy consisted of thyroid extract, 60 mg; cortisone acetate, 15 mg; and methyl testosterone, 10 mg. The latter was stopped 16 days prior to the beginning of this study, while the thyroid and cortisone administration was continued. There was no alteration in weight associated with the cessation of androgen therapy.

During the period of study, a known dietary intake was given consisting of 80 g of protein, 60 g of fat, and 178 g of carbohydrate, a total of 1700 kcal per 24-hour period. The sodium and potassium contents of the diet were 86 and 88 milliequivalents per 24 hours, respectively, the calcium and phosphorus contents 1358 and 1390 mg per 24 hours, respectively. Corrections were made for dietary returns when they occurred. The fluid intake was kept constant at 2500 ml per 24 hours.

A wide variety of determinations were performed on daily 24-hour urine collections, 72-hour stool collections, and frequent blood samples. The preliminary data concern the effects of growth hormone on the nitrogen, potassium, phosphorus, calcium, and sodium balance, as well as on the urinary excretion of aldosterone.

The human growth hormone was prepared from pituitaries obtained at autopsy (*13*), and the monkey growth hormone from pituitaries made available as a consequence of the poliomyelitis vaccine program. The extraction procedure was carried out by M. S. Raben (*12*). The growth hormone in a slightly acid *p*H was administered intramuscularly every 6 hours. There were no local reactions to its injection, but certain personality changes occurred (*14*). In addition, the patient was oliguric on the fifth day and anuric on the sixth day of administration of monkey growth hormone.

The data on metabolic balance are summarized in Table 1. Human and monkey growth hormone resulted in a significant enhancement of nitrogen storage, which was evident on the second day of its administration. During the ad-

Table 1. Data on the metabolic balance. Day 1 was 26 Aug. 1956. HGH, human growth hormone; MGH, monkey growth hormone; meq, milliequivalents.

Day of study	Therapy (mg/24 hr)	Wt.	N balance (g/24 hr)	P balance (mg/24 hr)	Ca balance (mg/24 hr)	K balance (meq/24 hr)	Na balance (meq/24 hr)	Urinary aldosterone (mg/24 hr)
1		73¾						
2		73¾	+ 0.36	− 8.3	+ 50.6	− 9.0	− 5.0	
3		74½						
4		73½						
5		73½	+ 0.8	− 4.6	+ 77.3	− 2.3	+ 32.5	2.8
6		73¼						
7		73						
8		74½	+ 2.5	+ 78.3	+ 15.0	+ 4.5	+ 15.0	2.8
9	HGH	73¼						
10	10	73						
11	10	73	+ 4.2	+ 464.0	+ 340.0	+ 28.1	+ 58.5	6.1
12	10	74¼						
13	20	74½						
14	20	75	+ 5.2	+ 578.3	+ 434.0	+ 15.1	+ 69.3	11.6
15	20	74¾						
16	20	76						
17	20	75	+ 5.9	+ 392.0	+ 266.6	+ 11.3	+ 54.8	14.2
18	20	75						
19	20	75½						
20	20	76	+ 5.8	+ 475.0	+ 355.5	+ 42.0	+ 57.6	20.2
21		75½						
22		76	+ 5.0	+ 180.0	+ 81.0	+ 8.4	+ 23.9	14.2
23		76½						
24		75½						
25		74½	+ 3.1	+ 279.0	+ 171.0	+ 10.0	+ 4.1	5.5
26		74½						
27		74½						
28		73	+ 3.7	+ 321.0	+ 213.0	+ 15.7	− 11.3	3.2
29	MGH	73						
30	40	73						
31	40	76	+ 5.6	+ 546.0	+ 525.0	+ 36.9	+ 28.2	7.7
32	40	76						
33	80	76						
34	80	75½	+ 7.6	+ 528.0	+ 287.3	+ 39.1	+ 65.9	12.0
35	80	74						
36		73						
37		73¾	+ 4.5	+ 407.0	+ 433.3	+ 18.6	+ 75.7	7.5
38		73¾						
39		73¾						
40		74	+ 1.2	+ 128.3	− 188.3	− 3.1	− 22.1	9.3

ministration of both preparations of growth hormone, there was a retention of potassium, phosphorus, calcium, and sodium. The positive balances of the various substances studied was in part the result of a fall in their fecal excretion. There was a gain in body weight during both periods; the weight was maintained for 4 days after administration of the human material was stopped. There was a significant increase in urinary excretion of aldosterone during both periods of administration of growth hormone. This was most marked with the human growth hormone and was not accompanied by any alteration in urinary 17-hydroxy corticoid and 17-ketosteroid excretion. Impairment of the glucose tolerance curve was evident after 10 days of administration of the human growth hormone. No change in glucose tolerance was demonstrable on the fifth day of administration of monkey growth hormone.

The rather striking physiological effects obtained with human and monkey growth hormone in this study, if confirmed, are in contrast with the equivocal effects of the bovine preparations in man and lend support to the concept of species differences in the molecular structure of growth hormone. Recently Li (*15*) has reported on the difference in chemical and physical properties of bovine, monkey, and human growth hormone and has suggested that these various growth hormones possess a similar "core" with variations in the remaining part of the molecule which account for the species differences observed.

The effect of human and monkey growth hormone in causing an increase in aldosterone excretion in this patient is of interest in relation to previous investigations carried out with bovine growth hormone. Earlier studies by Venning *et al.* (*16*) with crude preparations of bovine growth hormone in healthy subjects suggested a stimulating effect on aldosterone excretion. When these experiments were repeated with highly purified preparations, Venning *et al.* (*17*) were unable to demonstrate any effect on the excretion of the hormone. Whether the present findings are the result of the specific effect of human and monkey growth hormone on aldosterone secretion or the result of some contaminant present in the preparations remains to be clarified.

The difference in the effect of the human and monkey growth hormone on the glucose tolerance curves carried out during its administration might either be due to differences in the length of administration of the hormone or to an actual species difference.

These data would suggest that the physiologically effective dose of human growth hormone prepared by the Raben technique is less than 10 mg per 24 hours, and further studies concerning this will be made as supply of the material permits.

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7 March 1957

Behavior, Sexual Dichromatism, and Species of Parrot Fishes

During a study of social behavior of parrot fishes (Scaridae) at the Bermuda Biological Station (*1*) in the summer of 1956, it became evident that many of the forms hitherto listed as species were of only one sex. Our first suspicion of this arose when we observed aggregations that included only two species. In each situation the aggregation included at least one brightly colored parrot fish among several-to-many inconspicuously colored ones. The sexual dimorphism is so pronounced that previous authors (*2*) have accorded species status to the male and female color phases.

Our methods of determining which male and female belonged together were (i) observation of the spawning aggregations and other associations of the color forms recognized, (ii) injection of testosterone into females of a certain color pattern, followed by observation of the resultant male color pattern, and (iii) comparison of morphologic characteristics. The list of synonomies and the reason for each action is given, in abbreviated form in subsequent paragraphs.

1) *Scarus gnathodus* (Poey) (female and immature) is a synonym of *Scarus vetula* (Block and Schneider) (male). This observation was first made by L. P. Schultz of the National Museum (Washington, D.C.), who could find no morphologic differences between the two currently recognized species except in the color pattern of adults. Because of the poor state of preservation of specimens available to him, he was unable to distinguish the sexes. These two forms are synonomized for the following reasons. All *S. vetula* examined were adult males; most adult-size *S. gnathodus* were females. The black-and-white colored *S. gnathodus* was the only form found in the immature stages. One adult of *S. vetula* was usually seen surrounded by from two to five adult *S. gnathodus* on the reefs. These were aggregations that were defended and led by the male *S. vetula*. Injections of testosterone caused adult females of *S. gnathodus* to transform into the bright blue and red pattern of *S. vetula*. Morphologically the two are similar with respect to scale numbers, body form, fin ray numbers, and so on.

2) *Scarus punctulatus*, Cuv. and Val. (male) is placed in the synonymy of *Scarus croicensis* Bloch (female and immature) on the basis of the following evidence. All *S. punctulatus* examined were males, and almost all adult-size *S. croicensis* were females. Only the black-and-white colored *S. croicensis* appeared in an immature stage. One or two adults of *S. punctulatus* were almost always in schools with several-to-many adult *S. croicensis*. Injections of testosterone into female *S. croicensis* transformed their black and white color into the bright blue-green and red color pattern of *S. punctulatus*. Morphologically the two are similar.

3) *Sparisoma distinctum* (Poey) (female and immature) is a synonym of *Sparisoma aurofrenatum* (Cuv. and Val.) (male). This statement is based on the following evidence. All *S. distinctum* examined were either adult females or immature; all *S. aurofrenatum* were adult males. Males of *S. aurofrenatum* were observed to spawn with females of *S. distinctum*. Adults of both, in the breeding season, were usually seen together in loose aggregations. Except for the more intricate color pattern of red and yellow, *S. aurofrenatum* is morphologically similar to *S. distinctum*.

4) *Sparisoma abildgaardi* (Bloch) (female and immature) appears to be a

synonym of *Sparisoma viride* (Bonnaterre) (male). The evidence, although not as strong as in the examples already cited, seems to warrant synonomizing these two forms. All *S. viride* examined were males, and all *S. abildgaardi* examined were females. Only immature stages of the *S. abildgaardi* red color phase were found, and only large, mature *S. viride* in their bright green phase were observed. During the breeding season, the adult red females of *S. abildgaardi* and the adult green males of *S. viride* were usually seen together in loose aggregations. Individuals of *S. viride* frequently chased individuals of *S. abildgaardi* but did not chase other parrot fishes. Also, it was noted by Longley (*2*) that *S. viride* has a spotted color phase similar to that of *S. abildgaardi*.

Brock and Yamaguchi (*3*) identified two species of Pacific Ocean parrot fishes as the male and female of each other. A similar finding has been described in the case of only one other species of parrot fish (*Sparisoma radians*), in the western North Atlantic Ocean (*2*).

These results further demonstrate the occurrence of sexual dimorphism in coral reef fishes and especially in the family Scaridae, which has been considered not to be sexually dimorphic, in general (*4*, *5*).

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19 February 1957

Synthesis and Pharmacology of the Octapeptide Angiotonin

Arterial hypertension of renal origin seems to depend, at least during its initiation, on the liberation of a pressor substance from the kidneys. In 1939 a substance with the theoretically required properties was discovered simultaneously by Page and Helmer (*1*) and Braun-Menendez, Fasciolo, Leloir, and Munoz (*2*). It resulted from the action of a proteolytic enzyme, renin, which was extracted from kidneys, on a substrate synthesized in the liver and contained in plasma.

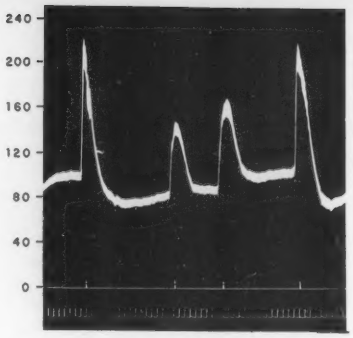

Fig. 1. Arterial pressure response in a dog under pentobarbital anesthesia and cardiovascular reactivity augmented with tetraethylammonium chloride. The marks on the abscissa indicate, left to right: (i) 5 μg of noradrenaline; (ii) natural angiotonin; (iii) synthetic angiotonin; (iv) 0.06 mg of serotonin.

More recently, Peart (*3*) isolated from the incubation mixture of renin (rabbit) and renin-substrate (beef) a pressor peptide containing ten amino acids (*4*) in the sequence L-asp, L-arg, L-val, L-tyr, L-val, L-his, L-pro, L-phe, L-his, L-leu (*5*). Skeggs *et al.* (*6*) obtained from the action of renin (hog) on its substrate (horse) a mixture of two vasoactive peptides, separable by countercurrent distribution, which they termed hypertensin I and II. They demonstrated that hypertensin I was converted into II by a chloride-activated enzyme occurring in plasma (*7*). Hypertensin I was shown to be a decapeptide with the sequence L-asp, L-arg, L-val, L-tyr, L-isoleu, L-his, L-pro, L-phe, L-his, L-leu; hypertension II was shown to be the corresponding octapeptide lacking the last two amino acids (*8*). Hypertensin I seemed to be inactive in the absence of converting enzyme (*7*).

In our work on the purification of angiotonin (hog renin, hog substrate), we were able to separate by countercurrent distribution an oxytocic-pressor principle from the dominantly pressor principle (*9*). The latter was transformed into the former by an enzyme present in whole, unhemolized blood, plasma, substrate fractions, hemolyzed red cells, and possibly urine. Distribution coefficients suggested a close relationship of the two principles with the two hypertensins of Skeggs *et al.* This was confirmed for the pressor principle, which we found to be identical with hypertensin I in amino acid composition and sequence.

On the basis of these data, it seemed very likely that the oxytocic-pressor principle was identical with hypertensin II. In order to determine the identity of these two principles, synthesis, based on the structure determined by Skeggs and coworkers for hypertensin II, was undertaken (*10*).

The four pure, crystalline dipeptides, cbz-β-Me-L-asp-NO_2-L-arg, cbz-L-val-L-tyr-Me, cbz-L-isoleu-L-his-Me, and L-pro-L-phe Me · HCl served as starting material. From the condensation of cbz-L-val-L-tyr-azide with L-isoleu-L-his-Me, a tetrapeptide was isolated. The carboxylic acid obtained from this tetrapeptide was condensed with L-pro-L-phe Me by the amide modification of the diethyl chlorophosphite method of Anderson and coworkers (*11*), to give the hexapeptide cbz-L-val-L-tyr-L-isoleu-L-his-L-pro-L-phe Me. The mixed anhydride formed from cbz-β-Me-L-asp-NO_2-L-arg-L-val-L-tyr-L-isoleu-L-his-L-pro-L-phe Me (mp, 182 to 185°C; $\alpha_D^{25} = -60.1$, $c = 1$ in methanol; $\alpha_D^{25} = -32.5$, $c = 1$ in dimethylformamide). After the removal of the protecting groups by hydrolysis and hydrogenolysis, a biologically active solution was obtained (20,000 units/mg of N). From this solution, a white powder was isolated containing a strongly pressor material and NaCl. After correction for NaCl, the activity was found to be 4000 units/mg of solid and by nitrogen determination as 22,000 units/mg of N (*9*). Pure natural angiotonin has an activity of 45,000 units/mg of N and 7800 units/mg of solid. Further purification of the synthetic angiotonin will be necessary before final comparison is justified. The material was also very active

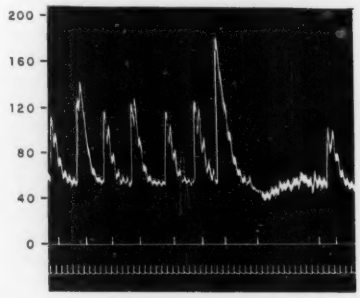

Fig. 2. Arterial pressure response in a pithed cat, comparing natural and synthetic angiotonin. The marks on the abscissa indicate, left to right: (i) 0.35 μg of solid synthetic angiotonin; (ii) 2 units of natural angiotonin; (iii) 0.41 μg of synthetic angiotonin; (iv) 1.6 units of natural angiotonin; (v) 0.41 μg of synthetic angiotonin; (vi) 0.47 μg of synthetic angiotonin; (vii) 5 μg of noradrenaline; (viii) 4 mg of benzodioxane per kilogram; (ix) 5 μg of noradrenaline; (x) 0.47 μg of synthetic angiotonin.

on an isolated rat's uterus. On two-dimensional paper chromatography, the material showed the expected eight amino acids in about equal quantities.

Comparison of the naturally occurring angiotonin with the synthetic showed that the form of the curve of arterial pressor rise in dogs, cats, and rats was identical with the same latent period as well. Neither had any significant effect on heart rate in vagotomized animals. Repeated injections produced no simple tachyphylaxis.

Augmentation of the response following injection of the ganglion blocking agents, tetraethylammonium chloride or hexamethonium chloride (*12*), occurred in large measure and equally with both the natural and synthetic substances. An example of such augmented response to noradrenaline, natural and synthetic angiotonin, and serotonin is shown in Fig. 1.

The responses in pithed cats were brisk and regular. A comparison of a "standard" sample of natural angiotonin and the synthetic is illustrated in Fig. 2. This experiment proves that the central nervous system is not necessary for the action of synthetic angiotonin.

The greatly enhanced response to noradrenaline (5 μg)was blocked by injection of benzodioxane. Both synthetic and natural angiotonin continued to elicit good rises in blood pressure, as did serotonin. This shows the site of action to be different from that of the usual pressor amines. The evidence obtained thus far makes it appear likely that our oxytocic-pressor principle from angiotonin is identical with hypertensin II.

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11 February 1957

Conversion of Diiodophenols to Side-Chain Analogs of Thyroxin

Interest in thyroxin analogs with side-chain variants was initiated by the early work of Harington (*1*) and subsequently renewed by Loeser and Trikojus (*2*), Frieden and Winzler (*3*), Barker *et al.* (*4*), Thibault and Pitt-Rivers (*5*) and Tomita and Lardy (*6*). Several summaries of these and other results on compounds with thyroxinlike activity have appeared (*4, 7*). Because of the great interest in side-chain analogs of thyroxin, we have been exploring several substituted diiodophenols as a source of corresponding diphenyl ether derivatives with appropriate side-chain functional groups. These condensation reactions are analogous to those suggested for 3,5-diiodo-L-tyrosine (DIT) by Harington (*1*), first shown by Ludwig and Von Mutzenbacher (*8*) and studied extensively by others (*9*).

An experimental basis for this approach was suggested when it was found that the biological activity of DIT and other substituted phenols increased with the age of the solution under test (*3, 10*). The percentage decrease in the total body length of toad tadpoles was used as a criterion for thyroxinlike activity as previously described (*3*) and in representative data summarized in Table 1. Each compound was dissolved in tap water, usually with the aid of dilute NaOH, and the solution was adjusted to *p*H 7.5 ± 0.3 with dilute HCl. Each experiment in Table 1 is the average of at least one duplicate of five animals per bowl incubated for 60 ± 20 hours at 29°C. Experiments 1 to 10 in Table 1 contained freshly prepared solutions of DIT (*11*). Aged DIT solutions (stored in brown bottles at 22°C at *p*H 7.5 for 10 months) were used in experiments 11 and 12. Thus freshly prepared DIT showed significant biological activity only in the absence of appreciable amounts of 2-thiouracil. The activity of DIT appeared to vary inversely with the thiouracil concentration. Another goitrogen, 2-mercaptoimidazole, similarly prevented DIT activity. As expected, aged solutions of DIT contain preformed thyroxin, and no effect of thiouracil was detected. Pitt-Rivers (*12*) has also noted the inhibition of the chemical conversion of DIT and its derivatives to the corresponding thyroxin compounds by thiouracil and other goitrogens.

Table 1 also presents data obtained from similar experiments with other single-ring compounds (*13*). All the substituted phenols tested showed thyroxinlike activity except 3-iodo-L-tyrosine (*14*) (experiments 13 to 15). The data in Table 1 include evidence for thyroxinlike activity for 3,5-diiodo-4-hydroxybenzoic acid (*15*) (experiments 16 to 18), 3,5-diiodo-4-hydroxyphenylacetic acid (*16*) (experiments 19 to 21), and 3,5-diiodo-4-hydroxyphenylpropionic acid (*17*) (experiments 22 to 24). In each case the biological activity could be prevented with thiouracil. The lesser activity of the benzoic acid compound (experiments 16 to 18) might be due to the relatively lower activity of its corresponding diphenyl ether, 4-(4′-hydroxy-3′,5′-diiodophenoxy)-3,5-diiodobenzoic acid (*3, 6*) (experiment 25) as compared with other diphenyl ethers, such as 4-(4′-hydroxy-3′,5′-diiodophenoxy)-3,5-diiodophenylpropionic acid (*18*) (experiment 26), L-thyroxin (*18*) (experiment 27), and L-triiodothyronine (*18*) (experiment 28). The addition of 3-iodotyrosine did not alter the response to DIT.

We have also studied the condensation reactions of substituted diiodophenols in an exclusively chemical system. Solutions (2 to 5 percent) of the 3,5-diiodo-4-hydroxy derivatives of benzoic, phenylacetic, and phenylpropionic acids were incubated under various conditions, and the reaction mixtures were

Table 1. Thyroxinlike activity of some substituted diiodophenols. The experimental conditions are summarized in the second paragraph of the text. The identity of the substituted diiodophenol involved in each experiment is given in the second and third paragraphs.

Expt. No.	Molarity of substituted diiodophenol	2-Thiouracil (%)	Decrease in length (%)
1	2.3×10^{-5}		12
2	5.8×10^{-5}		33
3	1.2×10^{-4}		48
4	2.3×10^{-4}		55
5	2.3×10^{-4}	0.0001	42
6	2.3×10^{-4}	0.0010	32
7	2.3×10^{-4}	0.010	25
8	2.3×10^{-4}	0.020	8
9	2.3×10^{-4}	0.005*	5
10	2.3×10^{-4}	0.010*	4
11	1.2×10^{-4}		56
12	1.2×10^{-4}	0.020	55
13	5.0×10^{-5}		3
14	1.0×10^{-4}		4
15	2.0×10^{-4}		4
16	1.3×10^{-5}		26
17	2.5×10^{-5}		42
18	2.5×10^{-5}	0.020	4
19	1.0×10^{-4}		44
20	2.0×10^{-4}		58
21	1.0×10^{-4}	0.020	3
22	4.0×10^{-5}		27
23	1.0×10^{-4}		54
24	1.0×10^{-4}	0.020	5
25	5.0×10^{-5}		41
26	1.0×10^{-7}		45
27	1.0×10^{-7}		31
28	1.0×10^{-7}		42

* The goitrogenic agent used in these two experiments was 2-mercaptoimidazole (*23*).

Table 2. Paper chromatography of substituted diiodophenols and some corresponding diphenyl ethers.

Compound	R_f*	Color of spot†
3,5-Diiodo-L-tryosine	0.27	pink
N-Acetyl-3,5-diiodo-L-tyrosine	0.36	pink
3-Nitro-L-tyrosine	0.15	yellow
3-Iodo-L-tyrosine	0.27	pink
3,5-Diiodo-4-hydroxybenzoic acid	0.16	yellow
4-(4′-Hydroxy-3′,5′-diiodophenoxy)-3,5-diiodobenzoic acid	0.71	purple
3,5-Diiodo-4-hydroxyphenylacetic acid	0.30	pink
4-(4′-Hydroxy-3′,5′-diiodophenoxy)-3,5-diiodophenylacetic acid	0.66	purple
3,5-Diiodo-4-hydroxyphenylpropionic acid	0.30	pink
4-(4′-Hydroxy-3′,5′-diiodophenoxy)-3,5-diiodophenylpropionic acid	0.64	purple

* R_f was determined in solvent of the following composition: *n*-butanol, 40 parts; NH_4OH, 15 parts; ethanol, 5 parts.
† The developing reagent for these spots was the diazotized sulfanilamide reagent prepared as described by Bolling *et al.* (*24*).

analyzed by paper chromatography. The systems described in Table 2 were used for the separation and the detection of the respective diphenyl ethers from the appropriate single-ring compound. It is of interest to note that the diphenylether compounds consistently gave purple test spots, while the single-ring compounds produced pink and yellow colors with diazotized sulfanilamide. Both the 3,5-diiodo-4-hydroxyphenylacetic and 3,5-diiodo-4-hydroxyphenylpropionic acids gave small yields of the corresponding acetic and propionic acid analogs of thyroxin when they were incubated at *p*H 7.5 at 37°C for 5 to 15 days. Occasionally, unknown compounds were detected in the incubation mixtures. No condensation product was detected from the incubation of 3,5-diiodo-4-hydroxybenzoic acid. Saul and Trikojus (*19*) have reported the condensation of 3,5-diiodo-4-hydroxyphenyllactic acid to its corresponding diphenyl ether.

A successful attempt was made to isolate 4-(4′-hydroxy-3′,5′-diiodophenoxy)-3,5-diiodophenylpropionic acid. An insoluble barium salt of this acid was isolated from an incubation mixture. It was triturated with dilute HCl and recrystallized several times from an equal mixture of alcohol and water. A small yield (no more than 1 percent) of the acid, which melted at 214° to 215°C, was obtained. The sample appeared to be identical with an authentic sample (*20*) of 4-(4′-hydroxy-3′,5′-diiodophenoxy)-3,5-diiodophenylpropionic acid as determined by mixed melting point, mixed paper chromatography, and infrared spectrum. This avenue of synthesis may be of value in the preparation of the acetic acid analog of thyroxin, a compound suggested as an important metabolite of the thyroid hormone (*21*).

In this article we have reported the conversion of certain substituted diiodophenols to the corresponding diphenylether derivative with the expected thyroxinlike activity. These condensation reactions may serve as simple models for the study of the mechanism of condensation of DIT to thyroxin. The *in vivo* biological activity of substituted diiodophenols with acid side chains has also been noted. The presence of a goitrogenic agent prevented the tadpole response. It is, therefore, probable that the biological activity of these single ring compounds is due to their conversion to the corresponding biologically active dephenyl ether. However, it cannot yet be ascertained whether the condensation reaction occurred in the tadpole incubation medium or in the organism (*22*).

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4 February 1957

Discrimination Training Effect on Stimulus Generalization Gradient for Spectrum Stimuli

It has been shown (*1*) that after the training of a pigeon to peck at a key illuminated by monochromatic light, a test for stimulus generalization during extinction with other wavelengths reveals an orderly relationship between wavelength and rate of responding. The experiment described in this report (*2*) was designed to determine how the generalization gradient is affected by explicit discrimination training.

An automatic Skinner box contained a translucent key illuminated by a diffraction grating monochromator (Bausch and Lomb model 33-86-40, with incandescent source, *3*). Thirty-two pigeons were trained to peck the key in an otherwise dark box with a stimulus light of 550-mμ wavelength (band width, 16.5 mμ). Food reward was given on a 1-minute variable-interval schedule. Five daily sessions were divided into 30 1-minute work intervals separated by 10-second "blackouts" during which no visual stimulus was present.

The birds were then divided into five groups. Eight birds, which were not given further training, were used to furnish a control generalization gradient. Four other groups of six were given discrimination training in which the positive stimulus was 550 mμ. The negative stimuli for the various groups were 555, 560, 570, and 590 mμ, respectively. The positive and negative stimuli were presented successively in random order for 1-minute intervals, separated by 10-second dark periods. Responses to the positive stimulus were rewarded according to the previous variable-interval schedule, while responses to the negative stimulus were never rewarded. Discrimination training was continued until a criterion of five successive minutes of no responding to the negative stimulus was met. The time required to meet the cri-

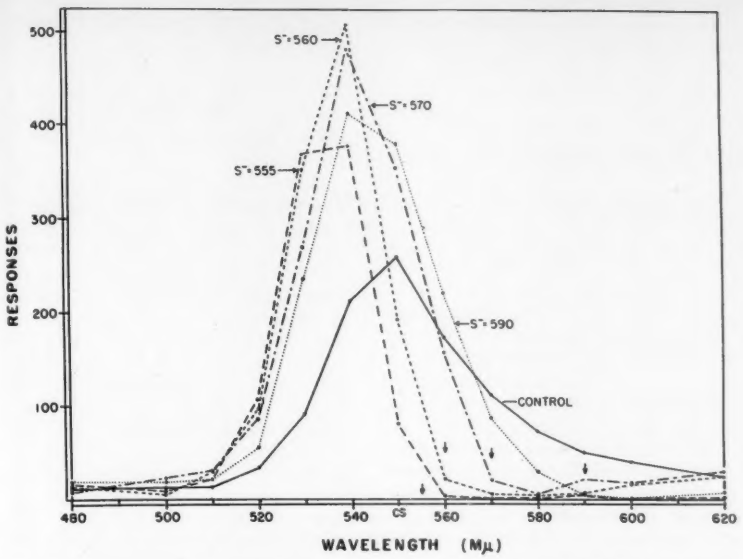

Fig. 1. Mean generalization gradients of a control group and four discrimination groups, identified by the respective values of the negative stimulus (S^-). Arrows indicate the positions of the negative stimuli.

terion of discrimination was a negatively accelerated decreasing function of stimulus difference.

Two generalization tests were administered to each bird on successive days. Each test consisted of 130 0.5-minute presentations of various wavelengths. Thirteen test wavelengths were used—480, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, and 620 mμ—and each was given ten times. Each block of the 13 stimuli was arranged in a different random order. The control group was tested after 5 days of training, and the discrimination animals were tested after they had reached the criterion of discrimination.

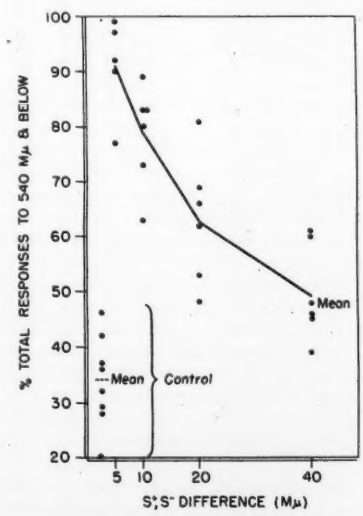

Fig. 2. Percentage of responses to wavelengths shorter than the positive stimulus, as a function of stimulus difference.

The mean generalization functions for all groups are shown in Fig. 1. These gradients were constructed by plotting the total number of responses to each stimulus against the wavelength of that stimulus. The postdiscrimination gradients, while they show many of the characteristics of the generalization curve obtained after simple conditioning, differ from the control in two ways. The postdiscrimination gradients are higher than the control curve, and they appear to be displaced along the abscissa in the direction of shorter wavelength. Only five of the birds in the four discrimination groups showed maximum responding at 550 mμ, and these five gradients evidenced truncation.

Both the right sides and left sides of the postdiscrimination gradients are ordered without inversion in relationship to the various values of the negative stimulus. The truncation of the curves for the groups trained with 555 and 590 mμ as negative stimuli is considered to be a consequence simply of the failure to include in the test series wavelengths near the inferred peaks of these functions, the phenomenon of displacement not having been anticipated. The displacement of the gradients for the discrimination groups may be illustrated by plotting for each subject the percentage of its responses which were emitted to 540 mμ and shorter wavelengths (Fig. 2).

The wavelength loci of the individual gradients which were truncated were estimated by a method of graphical linear extrapolation. The lines connecting the last two values on either side of the truncation were extended to their intersection and the value below the intersection on the wavelength axis was read off. These values, considered as differences from the positive stimulus, along with the similar values from those gradients that showed clear peaks when plotted against stimulus difference, show a clear relationship comparable to that in Fig. 2. The differences in "peak shift" among groups are significant beyond the 1-percent level of confidence in terms of an analysis of variance.

The differences in height between the experimental and control curves (Fig. 1), contrary to first impression, do not signify a correlated difference in total area under the curves. No significant differences between the means of groups were found for the total number of responses emitted during the two tests.

It may be observed that these results do not support the notion that discrimination training weakens behavior to the negative stimulus *and nothing more* (*4*). The evidence suggests that the major result of discrimination training is to bring a large proportion of the responses available in extinction under the control of another range of stimuli, those which do not ordinarily gain control of the response as the result of simple conditioning without differential reinforcement.

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References and Notes

1. N. Guttman and H. Kalish, *J. Exptl. Psychol.* 51, 79 (1956).
2. This paper is a condensation of a part of a dissertation submitted to the department of psychology, Duke University, in partial fulfillment of the requirements for the Ph.D. degree. This research was supported by grant M-1002 from the National Institute of Mental Health to Norman Guttman, who served as research adviser.
3. In order to obtain the maximum brightness level, the output of the monochromator was not adjusted for luminosity. The luminosity function, obtained by means of heterochromatic matches with a MacBeth illuminometer, is closely approximated by the tungsten emission curve multiplied by the human photopic visibility function.
4. A paper describing the theoretical significance of these findings is in preparation.

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24 January 1957

Book Reviews

Prehistoric Settlement Patterns in the New World. Viking Fund publications in anthropology, No. 23. Gordon R. Willey, Ed. Wenner-Gren Foundation for Anthropological Research, New York 1956. 202 pp. Illus. $5.

Interest which grew out of the papers presented, and the ensuing discussion, in a session on "Settlements and society: a symposium in archeological inference" at the annual meeting of the American Anthropological Association in Detroit, in 1954, led to a decision to publish the original five papers and to invite additional contributions by archeologists working in other New World areas. As a result, 15 new essays were received, and they, together with the original papers, an introduction, and an appraisal of their contents by an ethnologist, provide the contents of *Prehistoric Settlement Patterns in the New World.*

The introduction states that the purpose of the essays is to place on record present knowledge about prehistoric settlement patterns in various American areas and, thus, to provide basic source material and indicate problems for future studies on the significance of such phenomena. There are four articles on various aspects of the southwestern United States; one each on California, the Great Plains, the northern Mississippi Valley and the Great Lakes, the lower Mississippi Valley, the northeastern United States, the eastern United States, and the central Mexican region; two each on northern Mexico and the Guatemalan highlands; and one each on the Maya lowlands, Peru, the South American tropical forest, and the Caribbean area.

Because there are 22 authors involved and because no general outline or conditions were imposed, a number of different approaches are evident. All have the common denominator, however, of giving some consideration to the prehistoric settlement patterns, and to their possible meaning, in the area to which they pertain. Some deal mainly with that period, while others also include the early historic period, and some even the modern. Since much more work has been done through the years in some areas than in others, there is a great variation in the data available for study and a corresponding difference in the inferences which can be drawn from them.

Some unevenness in the essays is attributable to the fact that the range of phenomena which are included is not consistent and that there is not complete agreement on the concept of settlement patterns and their place in archeology, but this is to be expected under the circumstances of the writing. The need for much more information on certain areas is clearly shown. In some cases there are interesting discussions about the relationship of the settlement pattern to ecology and to the social structure and the ceremonial organization of the people involved as well as suggestions about other phases of the community life.

The closing paper of the volume, in an appraisal of the various essays, summarizes the salient points in each and offers constructive suggestions on how the information might be made much more helpful to ethnologists and how the latter could be of more aid to the archeologists. The Wenner-Gren Foundation made a definite contribution in providing funds for the publication of this volume. Anthropologists should find much of merit in it.

FRANK H. H. ROBERTS, JR.
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Die Gattungen der Rhodophyceen. Harald Kylin. Gleerup, Lund, Sweden, 1956. 673 pp. Illus. Cloth, SKr. 135; paper, SKr. 125.

In 1897 Adolph Engler published that volume of *Die Natürlichen Pflanzenfamilien* which synopsized the three great classes of macroscopic algae and first gave to botanists a complete modern classification of them, down to the genus, in a modern language, with analytic keys and illustrations. Ever since, this has served as a basic reference in systematic algal studies. However, its shortcomings soon showed what great need there was for detailed studies of the growth, structural, and reproductive mechanisms of most genera. These studies came forward rapidly; fundamental changes in classification became acceptable. A new edition was projected; that part dealing with the Chlorophyceae ("green algae") appeared in 1927. The depression and World War II struck; work on the "Pflanzenfamilien" and on "Das Pflanzenreich" was delayed and then stopped.

Harald Kylin of Lund, who had had a long history of accomplishment in studies on the structure and reproduction of the algae, had undertaken the most burdensome group, the Rhodophyceae ("red algae"). The manuscript was kept up to date until all hope of publication in the "Pflanzenfamilien" was gone, and then it was prepared for independent issue. Kylin's lamented death in 1949 did not deter his widow, Elsa Kylin, from finding support and a publisher, and with her editorial help and her supplementary notes, the present excellent volume is now available. It follows the general pattern of its predecessor. The introduction deals very briefly with general matters applicable to all red algae, such as cell wall and cell contents in structural and chemical aspects, but these are not exhaustively treated. Remarks on ecology and details of geographic distribution appear with the separate group descriptions. The greater part of the book is a systematic account of the subclasses, orders, families, and genera concerned. The text is entirely new and is fortified by an abundance of excellent illustrations which give a comprehensive coverage of the reproductive structures and developmental anatomy never before equaled. The dates of first description of the families and genera are given; typical species are designated. However, Kylin did not accept all the dicta of the International Code of Botanical Nomenclature, and of course the work, partly in type in 1954, could not be made to conform with the rules approved then and but recently published, so his "typical species" may not always qualify as the nomenclatural types, though his new families and genera, without Latin diagnoses, have appeared before the special deadline for algae.

The classification is very conservative. Most of the major changes have long since been adopted; few are new, but here, for the first time, they are all easily accessible. The 1897 counterpart of this work recognized the equivalent of only three orders; Kylin accepts ten. Fifty-six families are accepted, as compared with 24 before, and they are fundamentally regrouped, but the changes have not adequately affected the Ceramiales. This great order, with only four families but more than 250 genera, badly requires subdivision, and one regrets that Kylin, who had the breadth of knowledge, did not establish formal families among the groups he informally associates. The

number of genera listed increases from 341 to 568 [*sic*], nearly one-sixth of the increase being Delesseriaceae, favorite subjects of study with Kylin. One hears all too often of major pieces of work abandoned on the death of the author because they were too incomplete to be published or because loyal friends were lacking. This book is a fine memorial to Kylin and to his widow's unflagging devotion.

WM. RANDOLPH TAYLOR
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Physics and Chemistry of the Earth. vol. 1. L. H. Ahrens, Kalervo Rankama, and S. K. Runcorn, Eds. McGraw-Hill, New York; Pergamon, London, 1956. 317 pp. Illus. $8.

The continuing flood of scientific and technical papers requires the condensing of data and interpretations into manageable units so that the individual can maintain a broad acquaintance with science while keeping abreast of the advances in his own field of specialization. One device is the article that reviews the significant contributions whenever work in a particular field has progressed to the point that a retrospective evaluation is useful to the specialist and informative to scientists generally.

Pergamon Press and McGraw-Hill Book Company have embarked on producing annually as part of the "Progress Series" a volume on *Physics and Chemistry of the Earth*. The intent is to interest physicists and chemists in problems of our planet as well as to inform geologists of the state of knowledge in geophysics and geochemistry. The first volume is certain to succeed because of the emphasis on well-formulated statements backed by quantitative data, rigorous logic, and critical estimates of the probable validity. By the same token, the mathematics may repel a few who find the terms *very rare* to *abundant* sufficiently quantitative for all purposes.

The contents at first glance may give the reader the fleeting impression that six or seven out of the eight reviews deal with topics that have been bandied about at numerous conferences, symposia, and special sessions during the last 5 years: origin of the solar system, temperatures within the earth, radioactive methods for determining geologic age, seismology and the broad structure of the earth's interior, hydrodynamics of the earth's core, investigations under hydrothermal conditions, geochemistry of the halogens, and geochemistry in the U.S.S.R. Closer inspection immediately shows that the articles contain the basic information that a nonspecialist needs in order to profit from the papers and discussions at the various meetings. The specialist may disagree with the picture drawn, but he may well benefit from the critical appraisal made by a colleague of acknowledged competence.

Spencer-Jones traces the development of thought on the origin of the solar system by concise statement of the basis of each idea, the physical or chemical problem it is designed to meet, and the specific shortcomings that lead to its modification or abandonment. He suggests that theories premised on the cataclysmic interaction between the sun and another celestial body are less likely to succeed than theories premised on evolution from a solar nebula.

Verhoogen examines the methods used for deducing temperatures within the earth and inferring the sources of heat. He concludes that estimates based on assumptions about convection are preferable to those based on assumptions about conduction, but that it remains to be proved that convection does occur in the mantle. Studies of electric conductivity show promise for determining temperatures.

Ahrens gives the principal methods for determining geologic ages, with considerable emphasis on the problems and uncertainties, and points out potential methods that have not yet been exploited. Brief statements on meteorites and tektites are included, and the article concludes with references on methods not discussed: He, Ra, Io, photographic emulsions, cube edge, and radiation damage.

Bullen introduces seismology and then considers the broad structure of the earth's interior. Seven zones make up an earth idealized as a perfectly elastic, isotropic body; two earth models are presented. Bullen postulates that density distribution favors model B, the outer core is a high-pressure modification of the lower mantle, and the inner core is chemically distinct from the outer core.

Hide shows that the earth's magnetic field is due to circulating electric currents probably generated by hydrodynamical motion of the liquid conducting core; hence, a theory on magnetism is dependent on a theory of core hydrodynamics. Driving energy for the dynamo may come from precession, Urey's "sedimentation," and radioactive heating.

Roy and Tuttle review the post-1913 history of investigations under hydrothermal conditions, the most effective apparatus devised, and the results of mineral synthesis, phase equilibria, and liquidus studies. The data permit broader concepts of mineral and rock stability, of the development of very high pressures during crystallization in systems containing volatiles, and of the importance of alkalies to the solubility of water in a granite liquid.

Correns brings together a great mass of information on the geochemistry of the halogens, but the myriad gaps underscore his contention that geochemical preoccupation with cations has been matched by neglect of anions. The data are arranged in geologic order, ranging from cosmos and meteorites, through various rock groups, to hydrosphere and atmosphere, and concludes with a brief balance: fluorine originates principally from magmatic rocks, while iodine, bromine, and chlorine must come from the volatile phase of magma—unless the primitive ocean and/or atmosphere were rich in halogens. Of particular interest are the indications of worthy lines for future study.

Tomkieff summarizes the literature in Russian on geochemistry for the period 1948–53. The article as a whole is not easy reading but constitutes a compact guide to subjects and authors in six fields: geochemistry, geospheres, elements; minerals; mineral deposits; igneous rocks; sedimentary rocks; natural waters and evaporates. Each section carries its own references in addition to general author and subject indexes; the latter should not be confused with the name and subject indexes for the entire volume.

WILLIAM R. THURSTON
National Research Council

Chemistry of Chromium and Its Compounds. vol. I of *Chromium*. Marvin J. Udy, Ed. Reinhold, New York; Chapman & Hall, London, 1956. 433 pp. Illus. $11.

The value of a book such as this is immediately apparent when one considers that this volume, along with its companion volume II, covers all phases of the manufacture and uses of chromium metal, chromium alloys, and chromium chemicals as well as the chemical and physical properties. As the editor points out in the preface, no one person in this day could be expected to be sufficiently conversant with all phases of the science and technology of chromium to write such a book. This one is the work of 36 different and distinguished authors. It follows that no one reviewer could be sufficiently conversant with all phases of the subject covered to be able to give a really critical review of the book. Therefore, we must be content with the general impressions as they appear to me.

The 15 chapters in this volume are arranged in logical order and seem to cover the chemistry of chromium and its compounds. The book starts with a brief account of the history of chromium and continues, through the mineralogy and geology of chromium, to the analytic chemistry and the physical and chemical

properties. Finally, it discusses the industrial uses of chromium compounds. The volume also includes a chapter on the health hazards, which is certainly of primary importance in the protection of the workers in the chromium industries.

The book is excellent and satisfies the need for a comprehensive compilation of the data on the chemical and physical properties of chromium compounds. While it will probably not answer all the questions about the chemistry of chromium, it will, together with the books listed in the excellent bibliography, be a welcome addition on the desks of those scientists and engineers who are interested in the chemistry of chromium and its compounds.

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Freshwater Fishery Biology, K. F. Lagler (Brown). Reviewed by K. D. Carlander.

Die Flechtbinse (Scirpus lacustris L.), K. Seidel (Schweizerbart'sche Verlagsbuchhandlung). Reviewed by H. H. Iltis.

The Future of Arid Lands, G. F. White, Ed. (AAAS). Reviewed by A. W. Zingg.

Ceramics for the Archaeologist, A. O. Shepard (Carnegie Institution of Washington). Reviewed by P. V. Gardner.

Child Development, E. B. Hurlock (McGraw-Hill). Reviewed by P. H. Schoggen.

Microscopium, M. Rooseboom (National Museum for the History of Science, Leiden). Reviewed by R. P. Multhauf.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Dissection Guides. I, *The Frog*, 63 pp.; II, *The Dogfish*, Rowett. 61 pp.; III, *The Rat with Notes on the Mouse*, 64 pp.; IV, *The Rabbit*, 32 pp.; V, *Invertebrates: Earthworm, Crayfish, Cockroach, Lancelet, Swan Mussel, Snail*, 56 pp. Rinehart, New York, 1957. $0.95 each.

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Meetings and Societies

Recent Close Approach of Mars

On 7 Sept. 1956, the planet Mars was 35,131,000 miles from the earth, its closest passage since 1924. An equally near approach will not occur again until 1971.

When the American Astronomical Society met jointly with Section *D* of the American Association for the Advancement of Science in New York, 26–29 Dec. 1956, an afternoon session (28 Dec.) at the American Museum of Natural History was devoted to a symposium on "The recent close approach of Mars." The session was presided over by Fred L. Whipple, director of the Smithsonian Astrophysical Observatory. Those who presented communications were R. S. Richardson (Mount Wilson and Palomar Observatories), Seymour Hess (Florida State University and Lowell Observatory), G. P. Kuiper (Yerkes and McDonald Observatories), C. C. Kiess (National Bureau of Standards), C. H. Mayer (Naval Research Laboratory), and William Sinton (Smithsonian Astrophysical Observatory). No complete or final reports could be expected so soon after the event; full analyses of the data obtained during several weeks' observing will take many months. Discussions, necessarily, were progress reports and concerned the general nature of the observing programs. There were some preliminary results of special interest.

Since the rotation period of Mars differs from the earth's day by only 37 minutes, an individual observatory can obtain only a partial record of any given area of the planet. The sides visible from North America and Asia during a single week are almost mutually exclusive. In order to have more nearly continuous coverage, an international photographic patrol by ten observatories was set up under the International Mars Committee, with headquarters at Lowell Observatory, Flagstaff, Ariz. E. C. Slipher and A. G. Wilson, jointly, are secretaries of the committee. A patrol by visual observers was also organized to note the presence and movement of Martian clouds.

The program of Lowell Observatory was reported by Seymour Hess. Under the sponsorship of the National Geographic Society, Slipher worked at the Lamont-Hussey Observatory (University of Michigan) at Bloemfontein, South Africa, and obtained about 38,000 photographs of Mars. The peculiar W-shaped cloud that appeared in 1954 was again shown by blue photographs, during a short interval. Visibility of surface features at this opposition was relatively poor, owing to very dusty conditions in Mars' atmosphere. However, the new dark area east of Syrtis Major, first seen in 1954, was recorded, despite the unfavorable conditions.

The color of the dark areas, the so-called "seas," has often been described as distinctly green or greenish-gray. Richardson, with the 60-inch and 100-inch reflectors at Mount Wilson, found that the seas appeared slate-blue most of the time, though at the end of the observing period, in October, the blue color was definitely gone and they appeared gray-green. The change may have been a seasonal effect. Kuiper, using the 82-inch reflector at McDonald Observatory, compared the surface features with a color chart illuminated to simulate sunlight. Under the best seeing conditions the seas appeared, to him, neutral gray, but those near the polar cap had a brownish tinge. In the equatorial region there was no brown, but some areas had a slight moss-green tone. With poorer seeing, a greenish shade was more apparent. He suggested a psychological explanation. When seeing is poor, the eye tends to wander about, so that the green after-image affects the observer's impression of the color of the dark areas. The red deserts are not of a uniform color but show different yellowish and reddish tones.

Kuiper made an interesting suggestion concerning the permanence of the dark areas. It might be expected that yellow wind-borne dust from the deserts would eventually obliterate the seas unless they are renewed by growth of vegetation (Opik) or by deposition of new volcanic ash (McLaughlin). However, Kuiper points out that if they are lava, with a smooth, glassy surface, the winds would keep them swept clear. (I have grave doubts that the smoothness could persist for many millenia, in the face of weathering agents that must exist on Mars.)

The most spectacular feature of the observations was the vast dust cloud that hid Mare Sirenum and adjacent regions for several days, beginning 30 Aug. This appeared as a great, irregular, yellow ribbon, 3000 miles long. It may have caused obscuration even of the polar cap, which was invisible for several days and then reappeared.

The polar cap appeared to Kuiper to be either pure white or to have a slight tinge of ivory. The Lowell observations indicated that the cap shrank more rapidly than usual.

The famous "canals" seemed to be considered a minor problem and received only casual attention. Richardson, on one occasion, saw many canals with the 60-inch reflector, when Mars was about 74 million miles distant. To him they appeared blue, like the "seas," definitely not straight and fine but decidedly irregular, "like veins in some mineral." Kuiper stated that some canals, apparently, are not actual markings but are caused by the contrast at boundaries between areas of different tone in the reddish regions. These results are at least partly favorable to the conclusion, drawn by Antoniadi of Paris many years ago and later supported by Dollfus at Pic du Midi, that canals represent a merging of fine detail when they are viewed with inadequate resolving power. But the myth of possibly artificial canals will probably persist in the public mind for years to come.

Microwave emission from Mars was detected with the 50-foot paraboloid of the Naval Research Laboratory by C. H. Mayer, T. P. McCullough, and R. M. Slonaker. The radiation (wavelength 3.15 centimeters) was near the limit of measurement but definite. Evidently it is of purely thermal origin. Its strength is that of the emission from a black body of the dimensions of Mars and at a temperature of 230°K. No "thunderstorm static" like that of Jupiter or Venus has yet been received from Mars.

Sinton recorded the infrared spectrum of Mars with a lead sulfide cell. A minimum of radiation near 3.4 microns is tentatively attributed to the carbon-hydrogen bond resonance. If confirmed, this is favorable to the presence of some form of vegetation.

Hess discussed the cause of the "blue haze" in the Martian atmosphere. Both carbon dioxide and water vapor must be present. Condensation of each into snow has been suggested as the cause of the blue haze. Hess' calculations show definitely that carbon dioxide clouds would be too opaque. Water ice could produce the haze only if the frost point is near −90°C. This is consistent with the scarcity of water as shown by spectroscopic tests. It is therefore possible that water crystals cause the haze.

High dispersion spectra of Mars were

photographed by Kiess and C. H. Corliss (National Bureau of Standards) at the Slope Observatory of the U.S. Weather Bureau, Mauna Loa, Hawaii, and later at Georgetown University Observatory. Comparison with the spectrum of the moon showed no detectable lines of oxygen or water or the carbon dioxide bands at 7820 and 7882 A that appear in the spectrum of Venus. The Doppler shift of Mars' spectrum was enough to separate any such lines from those formed in our own atmosphere. This program was sponsored by the National Geographic Society. Richardson, with the 100-inch reflector at Mount Wilson, attempted to test the suggestion that water vapor might be more abundant near inferred sites of (hypothetical) Martian volcanoes. The result was negative.

Very little evidence was obtained that had a direct bearing on the hypothesis that the dark areas are wind-deposited volcanic ash. The recurrence of the W-shaped cloud of 1954 can be construed as somewhat favorable, but other mechanisms are possible.

Although the closest approach is past, 1956 was not the very last chance before 1971 to learn more about Mars. On 8 Nov. 1958, the planet will be about 45 million miles distant. The less favorable distance will be partly offset by a higher altitude above the horizon for northern observatories, so that effects of our atmosphere may be less serious, although generally poorer weather conditions can be expected at that time of year.

DEAN B. MCLAUGHLIN
Observatory, University of Michigan, Ann Arbor

Society Elections

■ National Wildlife Federation: pres., Claude D. Kelley; sec., Charles H. Callison, 232 Carrol St., NW, Washington, D.C.; treas., Louis W. Wendt. The vice presidents are Roland McClamroch, Paul A. Herbert, and F. Ross Brown.

■ American Economic Association: pres., Morris A. Copeland, Cornell University; sec.-treas., James W. Bell, Northwestern University. The vice presidents are Ben W. Lewis and Joseph J. Spengler.

■ Association for Symbolic Logic: pres., Stephen C. Kleene, University of Wisconsin; sec., Joshua Barlaz, Rutgers University. Representative to the AAAS Council is Ernest Nagel, Columbia University.

■ Board of Regents, National Library of Medicine: 1st chairman, Worth B. Daniels, Georgetown University; v. chairman, Champ Lyons, University of Alabama Medical College; sec., Frank B. Rogers, National Library of Medicine.

■ American Folklore Society: pres., Wayland D. Hand, University of California, Los Angeles; 1st v. pres., Sol Tax, University of Chicago; 2nd v. pres., Richard M. Dorson, Michigan State University; sec.-treas., MacEdward Leach, University of Pennsylvania; acting sec.-treas., G. Malcolm Laws, Jr., University of Pennsylvania. Representative to the AAAS Council is William N. Fenton.

■ Association for Computing Machinery: pres., John W. Carr, University of Michigan; v. pres., Richard W. Hamming, Bell Telephone Laboratories, Inc.; sec., Jack Moshman, Council for Economic and Industry Research, 734 15th St., NW, Washington 5, D.C.; treas., Charles Concordia, General Electric Company. Representative to the AAAS Council is Alston S. Householder.

Forthcoming Events

May

28–30. Trichomonas Infestations, internatl. symp., Reims, France. (Dr. Senechal, Société de Gynécologie, 31, rue Raynouart, Paris 16e, France.)

29–2. American College of Chest Physicians, annual, New York, N.Y. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago 11, Ill.)

30–31. American Geriatrics Soc., New York, N.Y. (R. J. Kraemer, Greenwood, R.I.)

30–31. Rheology of Elastomers, conf., Welwyn Garden City, Herts., England. (N. Wookey, British Soc. of Rheology, 52, Tavistock Rd., Edgware, Middlesex, England.)

30–1. American Acad. of Dental Medicine, 11th annual, Boston, Mass. (R. Diamond, 100 Boylston St., Boston.)

30–1. American Malacological Union, Pacific meetings, Santa Barbara, Calif. (Miss M. C. Teskey, P.O. Box 238, Marinette, Wis.)

30–1. American Ophthalmological Soc., Hot Springs, Va. (M. C. Wheelen, 30 W. 59 St., New York 19.)

30–1. Endocrine Soc., 39th annual, New York, N.Y. (H. H. Turner, 1200 N. Walker St., Oklahoma City 3, Okla.)

31–2. American Soc. for the Study of Sterility, New York, N.Y. (H. Thomas, 920 S. 19 St., Birmingham 5, Ala.)

31–2. Social Medicine, internatl. cong., Vienna, Austria. (T. Antome, Spitalgasse 23, Vienna 9.)

31–2. Society for Applied Anthropology, annual, East Lansing, Mich. (W. F. Whyte, New York State School of Industrial and Labor Relations, Cornell Univ., Ithaca, N.Y.)

June

1–2. American College of Angiology, annual, New York, N.Y. (A. Halpern, 15 E. 62 St., New York 21.)

1–2. American Diabetes Assoc., 17th annual, New York, N.Y. (ADA, 1 E. 45 St., New York 17.)

1–2. Soc. for Investigative Dermatology, annual, New York, N.Y. (H. Beerman, 255 S. 17 St., Philadelphia 3, Pa.)

1–9. International Cong. on Medicine and Surgery, Turin, Italy. (Secretariat, Minerva Medica, Corso Bramante 83–85, Turin.)

2–6. Air Pollution Control Assoc., golden anniversary, St. Louis, Mo. Jointly with American Meteorological Soc., American Soc. of Heating and Air Conditioning Engineers, American Inst. of Chemical Engineers, and American Soc. of Mechanical Engineers. (H. C. Ballman, APCA, 4440 Fifth Avenue, Pittsburgh 13, Pa.)

2–7. Society of Automotive Engineers, summer, Atlantic City, N.J. (Meetings Division, SAE, 29 West 39 St., New York 18.)

2–8. International Cong. of Photobiology, 2nd Turin, Italy. (G. Matli, Istituto di Fisica dell'Universita di Torino, Via Pietro Giuria 1, Corso Massimo d'Azeglio 46, Turin.)

3–5. American Soc. of Refrigerating Engineers, Miami Beach, Fla. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

3–5. Chemical Inst. of Canada, 40th annual, Vancouver, B.C. (CIC, 18 Rideau St., Ottawa 2, Ont.)

3–7. American Medical Assoc., annual, New York, N.Y. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

3–7. American Soc. of Civil Engineers, Buffalo, N.Y. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

3–7. Hospital Cong., 10th international, Lisbon, Portugal. (J. E. Stone, 10 Old Jewry, London, E.C.2, England.)

3–8. Microbiological Inst., 10th annual, Lafayette, Ind. (C. L. Porter, Dept. of Biological Sciences, Purdue Univ., Lafayette.)

3–12. Quantitative Biology, 22nd Cold Spring Harbor Symp., Cold Spring Harbor, N.Y. (B. Wallace, Biological Laboratory, Cold Spring Harbor.)

4–9. Blood Circulation, international symp., London, England. (D. G. James, c/o 11 Chandos St., London, W.1.)

5–7. Therapeutics, 5th international cong., Utrecht, Netherlands. (F. A. Nelemens, Bureau Provisoire, Vondellaan 6, Utrecht.)

6–7. Production Techniques, 1st natl. symp., IRE, Washington, D.C. (A. A. Lawson, Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va.)

6–8. National Soc. of Professional Engineers, Dallas, Tex. (P. H. Robbins, NSPE, 2029 K St., NW, Washington 6, D.C.)

6–8. Nuclear Structure Conf., Pittsburgh, Pa. (N. Austern, Radiation Lab., Univ. of Pittsburgh, Pittsburgh.)

8–11. American Planning and Civic Assoc., annual, Little Rock, Ark. (Miss H. James, APCA, 901 Union Trust Bldg., Washington 5.)

8–13. X-Ray Technicians, internatl. convention, Washington, D.C. (Miss M. A. Snyder, 1165 W. Water St., Elmira, N.Y.)

9–12. American Inst. of Chemical Engineers, Seattle, Wash. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–13. American Rocket Soc., semian-

Kodak reports to laboratories on:

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The general increase in the attainable sensitivity of photographic emulsions which we have perpetrated in the last couple of years now shows up in dental x-ray film.

For example, all things else being equal, the new *Kodak Periapical Ultra-Speed Dental X-ray Film* requires one twelfth the x-ray exposure that the old *Kodak Radia-Tized Dental X-ray Film* needed. This slower film, though itself now twice as fast as before, is still available to the dentist whose plan of attack calls for it. There is even a *Kodak Periapical Regular Dental X-ray Film* with half the speed of *that* (because the emulsion is on one side only).

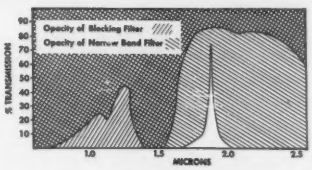
But the heightened sensitivity widens choice. If sharper pictures are needed, the x-ray source can be farther away. Alternatively, the pictures can be sharper because the patient doesn't have to hold those packets still against his gums so long. There are also other benefits. If you can't see for yourself what they are, don't bother your dentist about them.

Filters: plea and offer

Once every few years a queer sense of obligation compels us to spend our hard-earned money on advertising to acquaint the next cadre of technical people with the existence of *Kodak Wratten Filters*. Of these precisely dyed little sheets of gelatin we offer at present 116 different species, and though in truth they make little direct contribution to our prosperity, they do seem to contribute to the convenience of those who desire to modify the spectral distribution of radiant energy by simple and reasonably reproducible means.

The data book "Kodak Wratten Filters," which describes them all in the fullest, most quantitative spectrophotometric and colorimetric detail, has recently appeared in its 19th edition. Kodak dealers sell it for 75¢. The one niggardly favor we would ask in return for our magnanimity in selling the filters is that before an order is placed, this edition, and not one of its 18 predecessors, be consulted for current specifications and designations.

As for the newer-fangled and much costlier multi-layer interference filters, we make them but so also do several of our distinguished optical-manufacturing contemporaries. We shall not feel at all badly about your giving them your custom if you need transmission in the range up to 1.4μ. But if you find it necessary to specify a wavelength between 1.4μ and 4.5μ as a narrow transmission band or *any* wavelength above 1.4μ as a cut-off for a blocking filter—there we think you need us.



In that event, just state your problem to Eastman Kodak Company, Military and Special Products Sales Division, Rochester 4, N. Y.

A selective precipitant for sodium

The radio and TV newscasters have apparently failed to grasp the importance of this news (very few of them being biochemists), but word has very recently been received that DL-*Methoxyphenylacetic Acid* is a selective precipitant for sodium in the presence of large amounts of K^+, Ru^+, NH_4^+, Mg^{++}, Cl^-, NO_3^-, PO_4^{---}, SO_4^{--}, and up to 30 mg per ml of Li^+. And we gladly sell it as Eastman 7361, even providing an abstract if you like.

We first heard of DL-Methoxyphenylacetic Acid *as a plant growth regulator, but it wasn't spectacular. Now its new use makes it a pleasure to add it to our stock of some 3500 Eastman Organic Chemicals. For the abstract, chemical, or a copy of our List No. 40, write Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).*

Oscillographic opinion

Call us ingenuous (if not ingenious). Still it's easy to be amazed that it has become humdrum routine for patterns to be written at hundreds of miles per second and then frozen nigh forever for the minutest examination and debate. (Even the seemingly agile stream of electrons in your TV picture tube plods its monotonous course at scarcely 3½ miles to the second.)

The credit is not all ours. The manufacturers of oscillographs have contributed nobly to the feat. One of them recently was kind enough to offer us the rostrum of his company publication to vent our latest opinions about film for high speed oscillography.

Our opinions are that

1) It is going to be extremely difficult to improve on the speed and image quality you get from simply developing *Kodak Tri-X Film* in *Kodak Developer D-19* at 68 F for 10 minutes. (True the new *Kodak Royal-X Pan Film* enjoys a fourfold speed advantage over *Kodak Tri-X Film* for picture taking, but a force-developed line-image that's just over the threshold between being there and not being there is an entirely different proposition from picture taking.)

2) Development for 12 minutes in *Kodak Developer SD-19a* gives higher contrast. Under some circumstances this is as good as a gain in speed. But you pay in granularity.

3) Under some conditions, an overall postexposure of 1/500 metercandle for one second helps the oscillographic speed a little.

4) P-16 phosphors seem in many cases to be more satisfactory photographically than P-11 phosphors.

The most convenient way to get further details is to persuade Mr. L. Arthur Hoyt, Allen B. DuMont Laboratories, Inc., 760 Bloomfield Avenue, Clifton, N. J., that your technical sophistication entitles you to a place on the mailing list for "DuMont Instrument Journal," beginning with the May, 1957, issue.

Price quoted is subject to change without notice.

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Kodak
TRADE MARK

nual, San Francisco, Calif. (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

9–13. American Soc. of Mechanical Engineers, semiannual, San Francisco, Calif. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

10–12. American Nuclear Soc., 3rd annual, Pittsburgh, Pa. (W. W. Grigorieff, ANS, P.O. Box 963, Oak Ridge, Tenn.)

10–12. Canadian Soc. of Microbiologists, annual, London, Ont., Canada. (J. A. Carpenter, Dept. of Bacteriology, Ontario Agricultural College, Guelph.)

10–14. Molecular Structure and Spectroscopy Symp., Columbus, Ohio. H. H. Nielsen, Dept. of Physics and Astronomy, Ohio State Univ., Columbus 10.)

10–14. Technical Writers' Institute, 5th annual, Troy, N. Y. (J. R. Gould, TWI, Rensselaer Polytechnic Inst., Troy.)

11–13. American Meteorological Soc., Monterey, Calif. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

11–15. Ionization Phenomena in Gases, 3rd internatl. conf., Venice, Italy. (U. Facchini, Laboratori CISE, Via Procaccini 1, Milan, Italy.)

12–15. Colloquium of College Physicists, 19th annual, Iowa City, Iowa. (J. A. Van Allen, Dept. of Physics, State Univ. of Iowa, Iowa City.)

16–20. American Soc. of Mammalogists, annual, Lawrence, Kansas. (B. P. Glass, Dept. of Zoology, Oklahoma A.&M. College, Stillwater.)

16–21. American Soc. for Testing Materials, Atlantic City, N.J. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3.)

17–19. American Neurological Assoc., Atlantic City, N.J. (C. Rupp 133 S. 36 St., Philadelphia 4, Pa.)

17–19. Astronomical Soc. of the Pacific, annual, Flagstaff, Ariz. (S. Einarsson, Univ. of California, Berkeley 4.)

17–19. Health Physics Soc., 3rd annual, Pittsburgh, Pa. (H. W. Patterson, Radiation Lab., Univ. of California, Berkeley.)

17–19. Military Electronics, national convention, Washington, D.C. (G. Rappaport, Emerson Radio & Phonograph Corp., 701 Lamont St., NW, Washington 10.)

17–20. Carbon Conf., 3rd, Buffalo, N.Y. (Carbon Conf., Univ. of Buffalo, Buffalo.)

17–20. Institute of Aeronautical Sciences, natl. summer, Los Angeles, Calif. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)

17–21. American Soc. for Engineering Education, annual, Ithaca, N.Y. (W. L. Collins, Univ. of Illinois, Urbana.)

17–21. Association of Official Seed Analysts, annual, Baton Rouge, La. (L. C. Shenberger, Seed Lab., Dept. of Agricultural Chemistry, Purdue Univ., Lafayette, Ind.)

17–21. Canadian Medical Assoc., 90th annual, Edmonton, Alberta, Canada. (CMA, 244 George St., Toronto, Ont., Canada.)

17–22. Coordination of Galactic Research, internatl. symp., Stockholm, Sweden. (P. T. Oosterhoff, University Observatory, Leiden, Netherlands.)

17–22. Internal Combustion Engine Cong., 4th internatl., Zurich, Switzerland. (C. C. M. Logan, British National Committee, 6 Grafton St., London, W.1.)

(See issue of 19 April for comprehensive list)

LETTERS

The editors take no responsibility for the content of the letters published in this section. Anonymous letters will not be considered. Letters intended for publication should be typewritten double-spaced and submitted in duplicate. A letter writer should indicate clearly whether or not his letter is submitted for publication. For additional information, see Science **124**, *249 (1956) and* **125**, *16 (4 Jan. 1957).*

Political Means

Since I am only on a leave of absence from the United States, I feel free to comment on the article concerning the resolutions of the AAAS [*Science* **125**, 280 (1957)]. I was particularly struck by the statements concerning the lack of attention which greeted the recommendations of the Radiation Committee of the National Academy of Sciences. I should think the answer would be obvious. Any group that wants to enter the political arena to obtain politically what it desires must use political means. If most AAAS members and most other scientists back the findings of the Radiation Committee, as I think they do, it does no good simply to issue reports and hope for the best.

I would recommend that, if we desire action based on the recommendations, we should lobby for it. The AAAS should bring into being a political arm, should set up a lobbying group in Washington, should see to it that its members constantly relay to the public, through meetings, talks, and propaganda, its views, and should badger the scientifically interested public to write their Congressmen and express their views.

We should not be ashamed of this activity; we scientists have as much right to try to impose our views on the public as do other interest-groups. Only in this way can we make sure that not only our own interests but what we think are the interests of the country can be forcefully brought to the attention of the legislators.

PHILIP SIEKEVITZ
Rockefeller Institute for Medical Research, New York, New York

Feedback

Referring to your editorial of 15 March, "Feedback," there is proposed the problem of applying the brakes to the inflationary competition for scientists and engineers without discriminating against the governmental employee. It is questionable whether this competition will contribute enough to inflation to counterbalance the effect the lack of competition will have on the problem of the shortage of engineers. Many young students are not entering

engineering or science because of the salary level, which does not yet compare favorably with that of other professions and trades attained after a comparable number of years of experience. It is also widely felt that the engineering shortage is a temporary one created by large federal armament spending. It would be wisest and in the best interests of the country to increase the salary level of all research and development engineers and scientists, including biological and medical scientists, to a level which is at least commensurate with the training required and which will at least offer a sufficient return on the investment to induce those promising students of a practical nature to enter research.

NORMAN RABBINER
116½ Twelfth Avenue,
Belmar, New Jersey

I enjoyed your editorial "Feedback" in the recent issue of *Science* until I ran against the last sentence in which you wish to "find some way to apply the brakes without discriminating against the governmental employee," with regard to increases in salaries for scientists in government and industry. Obviously, there should be some limit to the ceiling on salaries, but I do not see why we need any brakes applied yet. If we are to attract young men into science in our present society, the only feasible method is to make science financially attractive to them. This, in my opinion, has not yet happened. They can do better in medicine and far better in business administration. Until the scientist receives a salary comparable to what he might get in these two and other fields, we have not solved the problem. Hence, I feel that no effort should be made to "apply brakes" yet.

FRED L. WHIPPLE
Smithsonian Institution,
Washington, D. C.

Scientists on Politicians, and the Obverse

J. Bronowski said: ". . . the decisions of state cannot be taken out of the context of science. . . .

"The fate of a nation may hang on an error of judgment here. Let me give you a slightly mischievous example. In 1945, the British Government published . . . a White Paper on the wartime development of atomic energy. Among the documents in this White Paper is the directive by which Mr. Winston Churchill . . . set up the project to make an atomic bomb. This directive begins with the words: 'Although personally I am quite content with the existing explosives. . . .'

"This bland phrase is a monument to a nonscientific education. . . . I do not much care for atomic bombs myself, but still less do I care to have them judged in phrases like Mr. Churchill's. In 1941, they might have weighed life and death between this country and Germany; and what brought down the scales was not the wisdom of statesmen, but the democratic tradition which caused Mr. Churchill to waive his own unwisdom.

"This example shows us succinctly what voters and statesmen do not know. I have called Mr. Churchill's astonishing phrase a monument to a nonscientific education. For it could have been written only by a man, an intelligent man, who simply does not understand how big a million is."

This remarkable series of statements was published once in Great Britain [*Advancement of Sci.* **12**, 301 (1955)] and once in *Science*, [**123**, 70 1956)] and was recently quoted in *Science* [**125**, 179 (1957)] by Dael Wolfle, who apparently takes them at face value

It is astonishing, and it is a prime example, but not of what the authors intended. Churchill's statement was obviously a bitter jest and nothing more. Doubtless, his knowledge of the devilish uses to which explosives can be put and his good judgment, rather than merely the "democratic tradition," "brought

down the scales" and permitted work on atomic energy to go ahead.

If Bronowski had any information concerning the former Prime Minister's opposition to the atomic studies other than his own peculiar interpretation of the White Paper, he should have stated it. If he did not have such information, his remarks are an example of drubbing a straw man, and their influence may not be merely "mischievous" but baleful, unless perchance they alert politicians to the need for educating scientists in politics, government, and similar matters.

GORDON GUNTER

Gulf Coast Research Laboratory, Ocean Springs, Mississippi

Causes and Effects

A comment may perhaps be in order on one point in the argument of Robert B. MacLeod, in his article on "Teleology and theory of human behavior [*Science* **125**, 477 (15 Mar. 1957)]. MacLeod is discussing the possibility of reintroducing the idea of teleology into science and suggests that the theory of relativity may permit us to relax the ideas of cause and effect that have prevailed since the Newtonian revolution. He says:

"If, however, we question the absoluteness of time and play with the idea that, in different frames of reference, the relationship between antecedent and consequent may be reversed, we may be left free to think that something that has not yet happened may be an essential condition of something that is about to happen. If the temporal relationship is relationally, rather than absolutely, determined, we might conceivably reincorporate purpose as a natural fact into the stream of natural causation."

It is here suggested that the theory of relatively cannot be strained to permit such a thought. Even though the "absolute" idea of time may have been overthrown, it is still not true that effects can, in any conceivable frame of reference, precede their causes. It is true that the time-order of two events may be reversed for two different observers, but it must be noted that this can happen *only if* the two events are in each other's "absolute elsewhere." The two events must be so far in space and so close in time that no signal from either event could possibly have arrived at the other in time to cause it. If two events are related in this manner for one observer, they are related in this manner for all observers. Such a pair of events could be described as "not possibly causal." But if two events are related so that a signal from *A* could have got through in time to cause *B*, then they are "possibly causal," and they have this "possibly causal" relationship, and in the same sense, *A* to *B*, for *all* observers.

It may be true to say, as MacLeod

does, that "space and time have ceased to be absolutes," but unfortunately this generalization is all too often misunderstood. Under certain circumstances, it may permit a reversal of apparent time-order, but under no circumstances does it permit a reversal of causality. We may indeed speculate whether something "might conceivably reincorporate purpose as a natural fact into the stream of natural causation," but this speculation should not be based on a misunderstanding of relativity.

ANTHONY STANDEN
250 Fifth Avenue, New York, N.Y.

Science, a Worth-While Endeavor

The mixed reactions, on the editorial pages of the newspapers [*Science* **125**, 269 (15 Feb. 1957)] (editorial), to the report of the Interim Committee on the Social Aspects of Science were no doubt duplicated in the mind of the general public. Science is widely considered to be amoral, being, in itself, neither good nor bad. Most of the practical applications of science are good, whereas a few of the applications are unquestionably evil. But in the mind of the public, amoral science is confused with its applications, and, depending on personal prejudice, "science" is seen as a good or as a potential evil.

Scientists can never hope for complete control over the applications of their work; the policies now being developed within the AAAS are based on this reality. It might be profitable, in order to further the development of these policies, to depart here from the obvious and indulge in a little speculation. A reexamination of the purposes of science may disclose a way to promote a more favorable attitude toward science on the part of the general public. As a start, it is proposed that the primary purpose of science is the attainment of certain knowledge of things by knowing their causes. All men, by their nature, desire to know. And if it is innate in man to wonder, to be curious, then surely the attainment of knowledge, however proximate or incomplete it may be, is, in itself, a good.

In a word, science, abstracting from its applications, is not amoral, it is a worth-while endeavor. If this point can be successfully taught to the general public, perhaps scientists, as a group, would be more easily able to recommend actions that seem, from the point of view of science, to be desirable. Perhaps, even, if it were eventually accepted as part of our cultural milieu that science is not amoral, that it is good in itself, more young men and women might choose it as a career.

JAY A. YOUNG
King's College,
Wilkes-Barre, Pennsylvania

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ PRESSURE TRANSDUCER SYSTEM measures rate of change of pressure. Pressure is sensed by a quartz piezoelectric element. Instead of measuring charge, which is proportional to pressure, the system measures current or rate of change of charge. Response rise time is said to be 15 sec. Ranges from 0-to-1 to 0-to-1000 lb/in². are covered. (Kistler Instrument Co., Dept. S303)

■ TEMPERATURE-COMPENSATING CAPACITOR of the air-dielectric type utilizes a bimetal bar to provide compensation. As it responds to temperature changes, the bimetal bar adjusts the stator of the capacitor. (British Radio Electronics Ltd., Dept. S294)

■ VACUUM SYSTEM designed primarily for vacuum coating reaches a pressure of 0.5 μ-Hg in 5 min; a pressure of 3×10^{-6} mm-Hg is attainable. Pressures are measured by Pirani and discharge gages. The work chamber is an 18- by 30-in. bell jar. (Consolidated Electrodynamics Corp., Dept. S332)

■ FREEZE-DRYING EQUIPMENT is described in an 18-page catalog. Included are descriptions of a complete portable unit and of histological, biological, infrared, and Roto-Freeze units and accessories. (Will Corp., Dept. S308)

■ THERMAL CONDUCTIVITY PROBE, designed by Pittsburgh Corning Corp., utilizes the principle that the temperature of a line heat source in a block of insulating material rises by an amount that depends on thermal conductivity. Temperature at the midpoint of the line source is measured by a thermocouple. The probe is 8½ in. long and 0.02 in. in diameter. Results are said to be reproducible to 1 percent. (Custom Scientific Instruments, Inc., Dept. S293)

■ MEASURING SYSTEM uses magnetic servo amplifier and a null-balance indicating receiver fed by transducers for pressure, flow, and temperature measurements. Pressure is sensed by a twisted Bourdon tube that actuates a rotary differential transformer to furnish an output voltage proportional to the variable. Bellows used for differential pressure and flow, feed similarly into a differential transformer. Temperature is converted into an electric signal by a resistance thermometer. (Norwood Controls, Dept. S310)

■ MULTIPLE INDICATOR is equipped with numbered push-button switches and scans up to 48 points. Full-scale travel of the 26-in.-long, drum-type scale requires 4.5 sec. The indicator is offered primarily for measurement of temperature but can also be supplied for measurement of other variables. (The Bristol Co., Dept. S290)

■ TEFLON TAPE reinforced with finely woven glass cloth is produced in widths of ¼ to 12 in. and in thicknesses from 0.002 to 0.06 in. The tape can be bonded with ordinary adhesives. The cementable surface is produced by treatment with a mixture of sodium and ammonia. It is claimed that reinforcement provides greater abrasive resistance, higher tensile strength, lower cold flow, and improved dimensional stability for Teflon tape. (Continental-Diamond Fibre Corp., Dept. S309)

■ FIVE-CHANNEL RADIATION MONITOR indicates radiation levels at five separate locations. Each channel is provided with a Geiger-Müller tube or a scintillation detector mounted at a distance of up to several thousand feet from the indicators. Indication of count rate is provided for each channel by contact-type meter relays that may also be used to actuate alarms. The five-channel instrument can be mounted in a 19-in. rack. (Universal Atomics Corp., Dept. S302)

■ PSYCHROMETER consist of wet- and dry-bulb thermometers and an electric fan that is powered by flashlight batteries. The range of relative humidities from 10 to 100 percent is measured. (Bendix Aviation Corp., Dept. S312)

■ RADIOCHEMICALS are available in solution form with specific activities 10 to 100 times higher than those of standard crystalline preparations. (Schwarz Laboratories, Inc., Dept. S325)

■ LABORATORY GLASSWARE utilizing stopcocks with Teflon plugs is described in a 16-page catalog. Included are precision burettes, aspirator bottles, gas collecting tubes, Karl Fischer apparatus, separatory funnels, nitrometers, and manifolds. (Fischer and Porter Co., Dept. S305)

■ PARTICLE-SIZE DISTRIBUTION ANALYZER, the Micromerograph, utilizes a technique in which powder particles are dispersed in air and allowed to settle, under the action of gravity, onto a servoelectronic balance. The output is a continuous plot of the weight of powder settled against time. Application of Stokes' law to the data yields a particle-size distribution curve. A test run requires 15 min and about 0.1 gr of sample. Compressed nitrogen is used to inject the powder into the sedimentation tube. (Sharples Research Laboratories, Dept. S306)

■ ELECTRONIC INDICATOR measures dimensional variations from 10 in. to 10 mils. The device consists of an adjustable gage head, an amplifier, and a stand. Displacements of the gaging tip, applied with a gaging force of ¾ oz, are amplified 10,000 times and displayed on a zero-center meter. (Cleveland Instrument Co., Inc., Dept. S279)

■ SODIUM REAGENT, a buffered aqueous-alcoholic preparation of α-methoxyphenylacetic acid, reacts with sodium ions to produce an insoluble sodium acid salt. The reagent is useful for quantitative as well as qualitative analysis. It is said that large amounts of NH_4^+, Mg^{++}, K^+, Rb^+, Cl^-, NO_3^-, and PO_4^{---} do not interfere. (Monroe Chemical Co., Dept. S307)

■ FLOW METER uses the modification of an ultrasonic beam to measure fluid flow. The instrument offers no obstruction to the fluid, thus eliminating pressure drop caused by the measuring means. Flow in the range of 1000 to 4000 gal/min is measured with an accuracy of 1 percent. A 5-v electric output is provided for feeding into standard telemetering and recording systems. (Gulton Industries, Inc., Dept. S263)

■ REFRACTOMETER used in conjunction with a monocular microscope and illuminator operates on the basis of the Rayleigh method of interferometry. Differences in refractive index in the fifth decimal place are measured with a range of 0.002. Sample volume is 1.6 ml. (American Instrument Co., Dept. S316)

JOSHUA STERN
National Bureau of Standards

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(a) Analytical Chemist, Ph.D., to direct group of analytical chemists; new research center, large industrial company, California. **(b) Pharmacologist,** Ph.D., research laboratory, pharmaceutical company; $7500–$10,000. **(c) Biochemist or Nutritionist** with some experience as science writer; duties include surveying literature for various departments, pharmaceutical company; $7000–$10,000; Midwest. **(d) Physiologist, Biophysicist, and Biochemist,** Ph.D.'s; research institute now under development; quarters adequate for present; emphasis on cardiovascular research; scope to be increased to other research fields; $10,000–$12,000; Midwest. **(e) Toxicologist;** although Ph.D. in pharmacology preferred, one with doctorate in biochemistry acceptable; industrial toxicology laboratory, large company; experience in industrial toxicology advantageous; $10,000. **(f) Clinical Physiologist,** preferably one whose background has been in respiratory physiology; M.D. or Ph.D.; university medical center; West. S5-1 Medical Bureau, Burneice Larson, Director, North Michigan Avenue, Chicago. X

Biochemist, Ph.D. to supervise clinical chemistry section of laboratory in 550-bed county hospital, metropolitan Detroit. About 55,000 chemical tests in 1956; about one-third of time for development of methods and one-third of time for original investigation. Salary $6723, annual increases $240; 40-hour week. Civil Service benefits, pension, social security, 12 holidays, liberal vacation, sick allowance, group hospitalization, and life insurance. Send photograph, résumé of training and experience, and references to Dr. S. E. Gould, Director of Laboratories, Wayne County General Hospital, Eloise, Michigan. 4/19, 26; 5/3

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Teaching Position in Botany. Open September 1957. Rank and salary dependent on qualifications and experience. Write Chairman, Department of Biology, College of St. Thomas, St. Paul 1, Minnesota. 4/26; 5/3

Technician. Electronic–mechanical to assist heart physiology research project, $4000–$4500. Physics or biology degree helpful. Small modern medical physics laboratory in Montana. Box 127, SCIENCE. 4/26; 5/3, 10

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Box 140, SCIENCE

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Bacteriologist; Ph.D.; 4 years, associate professor, microbiology, medical school; 5 years, senior scientist, pharmaceutical company. Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

Geneticist, 32; Ph.D. in zoology, postdoctoral training in biostatistics. Wants medical school or other human genetics position. Box 137, SCIENCE. X

POSITIONS WANTED

Microbiologist, Ph.D.; 5 years' medical school teaching, research, head clinical microbiology, serology. Desires teaching and/or research. Box 134, SCIENCE. X

Microbiologist, M.A., Ph.D. Teaching, research experience, animal viruses, medical bacteriology, tissue culture. Desires teaching and/or research position. Box 141, SCIENCE. 5/10

Microbiologist–Biochemist, Ph.D.; 4 years' experience in microbial biochemistry; laboratory and plant experience in fermentation; bioassay, chromatography, manometric and tracer technique. Box 120, SCIENCE. 4/19; 5/3

POSITIONS WANTED

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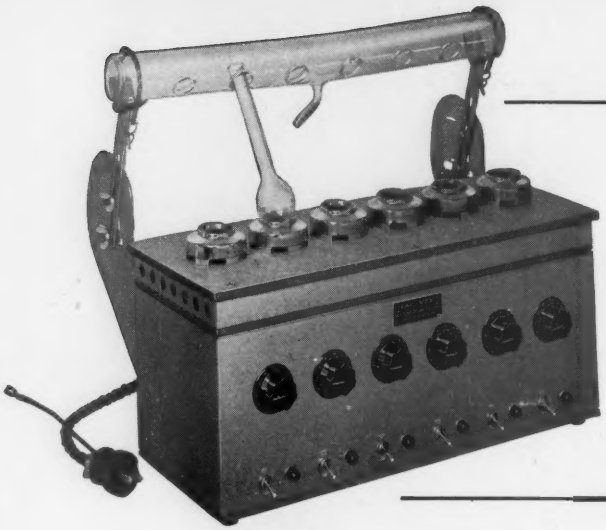

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Six separately controlled 200-watt heaters

Fume duct support adjustable to take flasks from 10 to 100 ml, and tubes of various sizes, at any desired angle

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Thomas-LABCONCO HIGH TEMPERATURE KJELDAHL DIGESTING APPARATUS

KJELDAHL DIGESTING APPARATUS, Micro, Electric, Thomas-Labconco. With six 200-watt heaters, each with separate rheostat control, pilot lamp and "on-off" switch, for completely independent operation at temperatures up to 450° C. Controls are mounted in a Stainless steel housing, and finish is corrosion resistant throughout. With fume duct of Pyrex brand glass. Support is adjustable to accommodate Kjeldahl flasks 10 ml, 30 ml or 100 ml capacity, making the apparatus suitable for micro or semimicro analysis. Heat production is adequate for larger Kjeldahl flasks* or for pressure digestions using sealed tube procedures. Fume duct is in accordance with "*Recommended Specifications for Microchemical Apparatus*," Division of Analytical Chemistry, American Chemical Society; see *Analytical Chemistry, Vol. 23, No. 3 (March, 1951), p. 524.*

The disc-shaped heaters, consisting of heating elements embedded in refractory cement, are spaced 3 inches from center to center on the transite top of the Stainless steel housing and are separated from the controls by a ventilated air chamber 1⅛ inch high, beneath which is a second transite strip. Each heater has a removable, circular top of Stainless steel with opening 26 mm diameter and concavity for supporting the bottom of a 30 ml Kjeldahl flask. Readily insertable wire gauze discs are available for use in openings of heater tops to support 10 ml Kjeldahl flasks and tubes less than 26 mm in diameter.

Individual switches, pilot lamps and temperature control knobs, with dials graduated in 10 arbitrary divisions, are mounted on front panel and are insulated by a transite panel from the six 50-ohm rheostats mounted in ventilated rear compartments. Housing is 19⅛ inches long x 7⅝ inches deep x 10$\frac{3}{16}$ inches high to tops of heaters.

Fume duct, 516 mm long x 51 mm outside diameter, has six openings 22 mm diameter for flask necks and slopes toward center for drainage through the central outlet tube, $\frac{7}{16}$-inch outside diameter. The fume duct is held in position by the Stainless steel, spiral springs of two slotted aluminum clamps supported by wing-shaped brackets at the back corners of the housing. The flexible attachment of the clamps to L-shaped slots in the brackets by two bolts with wing-nuts and washers permits easy adjustment to support flasks or test tubes up to 12 inches long at any preferred angle over a wide range.

*For use with Kjeldahl flasks 100 ml or larger, the Apparatus can be furnished at same price with heater tops to fit in place of the tops regularly furnished.

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